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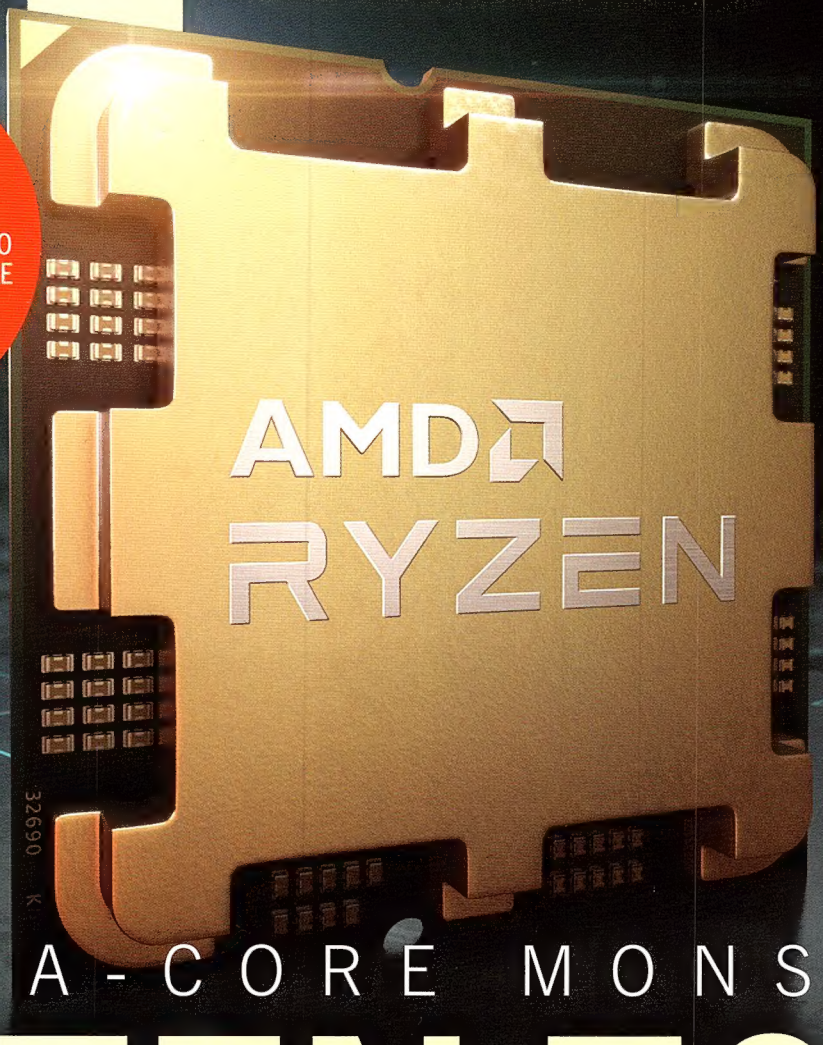

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EDITORIAL

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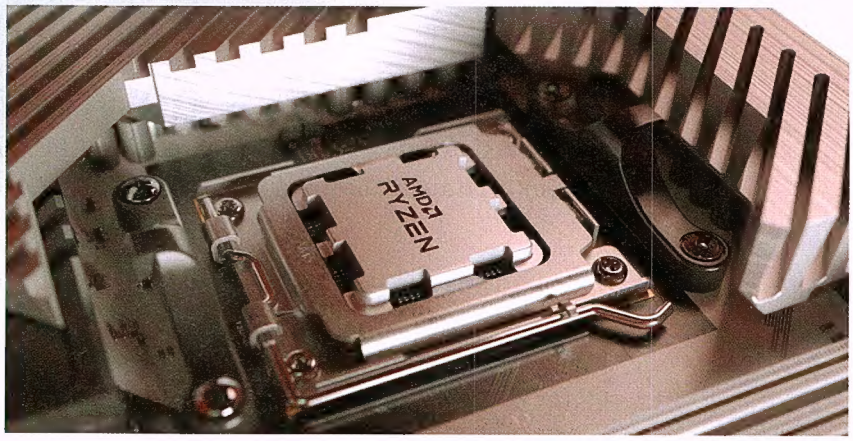

EDITORIAL

What a time

Truly golden.

BEN MANSILL
Is very excited about the PC right now.

Let's just take a moment, breathe in, try to relax, and look around at what's happening in the world of the PC right now...

AMD's Ryzen 7000 CPUs. AMD's AM5 motherboard platform. Intel 13th Gen (Alder Lake) CPUs. Nvidia 4000 series graphics cards. AMD RDNA 3 graphics cards. Intel Arc graphics cards.

And, PCIe 5 storage, OLED screens, ATX 3.0 PSUs. And DDR 5. And a few other things.

ALL AT ONCE. It's completely mental. Well, the big stuff isn't all dropping at *exactly* the same time, but over a period of no more than two months. Which still qualifies as ridiculous.

It's sent tech journos around the world into an almost unfathomable amount of benchtesting. Editors into defcon 1 states of extreme planning to be able to cover everything for you, and in good time.

The lucky winners, I suppose, are the well funded enthusiasts looking for a completely new system that packs the latest. Oh boy are they in for a treat. It's not often you can build a new PC where almost everything inside is the newest cutting edge gear. Literally only the cables and the case itself might be 'old' tech.

> "It's not often you can build a new PC where almost everything inside is the newest cutting edge gear."

Ryzen 7000 will need a new AM5 motherboard, and unless you just upgraded to a Z690 motherboard for Intel 12th gen, you'll need a new LGA1700 board. It's some consolation that these new platforms will offer upgrade compatibility, we're promised. The sane approach is probably to start with that CPU + mobo baseline of a new build, and carry over your previous graphics card until RDNA 3 and 4000 series cards become reasonably priced – or just grab a new 3080 or 6800 for a bargain price.

Looking at actually buying an Nvidia RTX 4090? Well, you'll probably want a new PSU, then, if you're currently running less than 1,000 watts.

We're at it here, and we'll be upgrading our Labs test bed soon, and we'll have that excitement explained in the next issue.

And what of pricing and availability? Apparently we have a year's worth of RTX 3000 series cards sitting in warehouses. Will anyone actually buy an RTX 4080 or RDNA 3 card when a 3080 or 3080 Ti can be had for prices that actually approach sanity?

It's wild. Chris has been locked in the Labs for days now, and we won't let him out until he finishes testing the Ryzen 7000 chips and AM5 boards, then he's going straight back in again to test Intel 13th Gen and Nvidia 4080 and 4090 cards, before we let him out once more for a trip to the US to cover the RDNA 3 launch.

Stay tuned. This issue and the next couple will be bangers.

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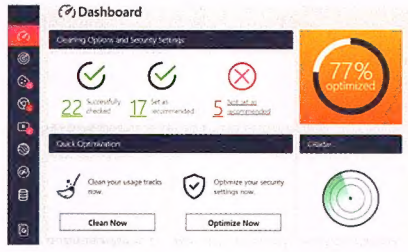

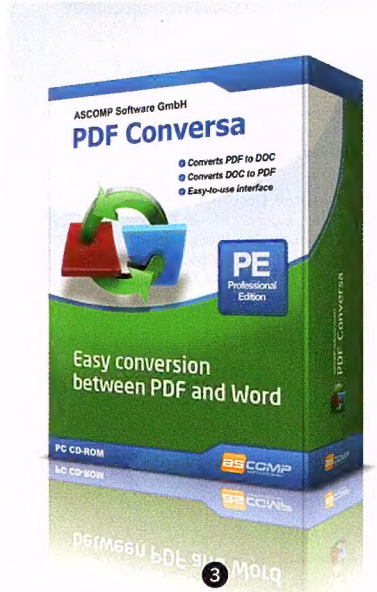

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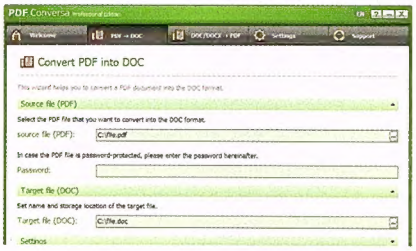

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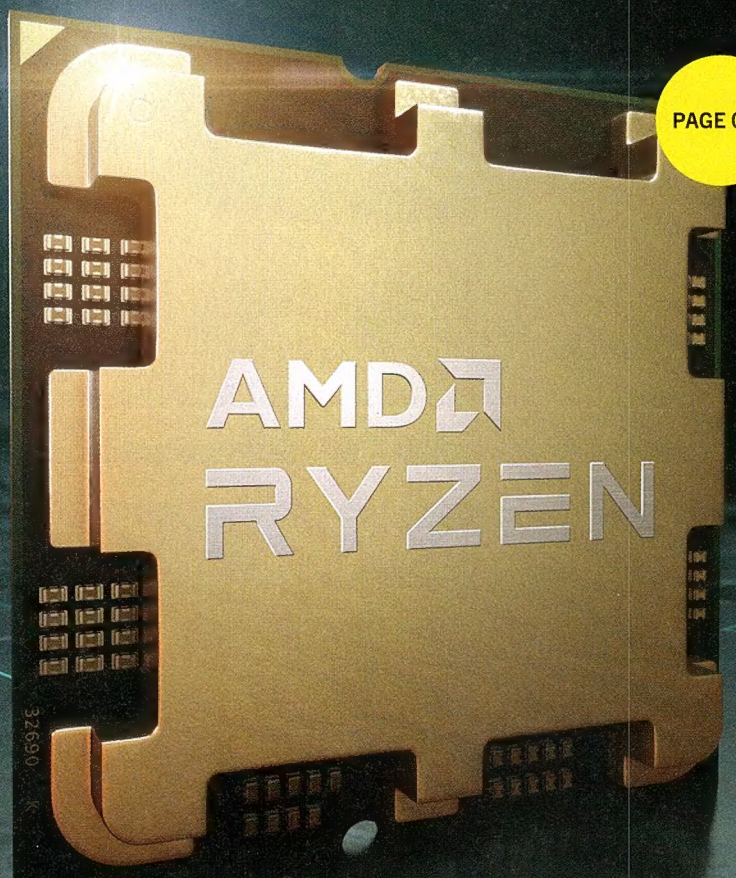
CONTENTS

APC513 DECEMBER 2022



PAGE 048

MEGA-CORE MONSTER

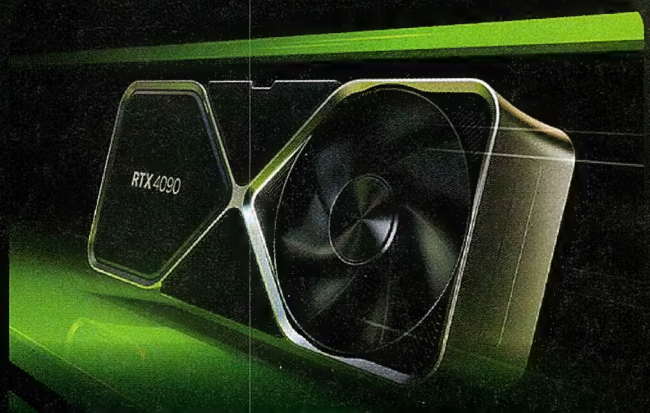
RYZEN 7000

LABS VERDICT: SHOULD AMD'S EPIC ZEN 4 BE YOUR NEXT UPGRADE?
PLUS AM5 BOARDS EXPLAINED & TESTED

LINUX IN SPACE

With the OS now established in astronautics, APC looks at its future prospects

064



NVIDIA ANNOUNCES RTX 4090, RTX 4080

Say hello to Ada Lovelace as Nvidia announces the RTX 4090 & RTX 4080

012

DELL XPS 15 (9520)

Can the XPS 15 outplay the MacBook Pro 16 with a new CPU, better battery and a hefty discount?

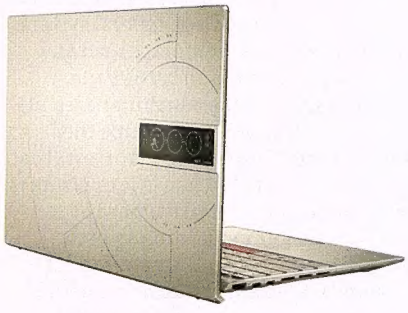
037

WD BLACK SN850X

042

LG GRAM 2-IN-1 16”

038



ASUS ZENBOOK 14X SPACE EDITION

039

EPOS ADAPT 660 AMC

043

SAMSUNG 55” ODYSSEY ARK

This screen is the most immersive monitor money can buy, but it comes with some major caveats that will be an Achilles’ heel for some.

041

TECHNOTES

010 **News**
Intel launches Raptor Lake
012 **Tech brief**
Nvidia announces RTX 4090, RTX 4080
014 **End user**
Stadia, and the risk of buying into new tech
015 **Random access**
What is the future of game streaming now that Stadia is dead?
016 **Two bits**
Intel’s Arc graphics cards are curiously absent from Australian shores
018 **Trade chat**
What happened to the end of Moore’s Law?
019 **One more thing**
No I will not rate the experience
022 **Futures**
Quantum internet is coming
026 **A-list**
The best products on the market, as picked by our editors
029 **The list**
Top 5 PC game controllers
030 **Head to head**
Plex vs Jellyfin
030 **Gadgets**
Techy toys and trinkets

THE LAB

036 MSI Prestige 14 Evo A12M
037 Dell XPS 15 (9520)
038 LG Gram 2-in-1
039 Asus Zenbook 14X Space Edition
040 Samsung Odyssey Ark
042 WD Black SN850X
043 Twelve South Curve Flex
043 Epos Adapt 660 AMC

SOFTWARE

044 Fing Desktop 3.0.0
045 Parrallels Desktop 18
046 DragonflyBSD 6.2.2

FEATURES

048 Ryzen 7000 & AM5 motherboards group test
058 Refresh rates 101
060 Tech that changed Australia Part 7
064 Linux in space
068 Best calendar apps for Mac
074 Update your drivers

PC BUILDER

080 **System news**
Nvidia launches GPUs as a partner launches a bombshell
081 **Market watch**
A sampling of PC systems available
082 **Blueprints**
Value- and performance-driven hypothetical builds

HOW TO

086 **Quick tips**
Solving a variety of tech problems
088 **Windows**
Fix PC problems with Windows 11
092 **Windows**
Create a 3D map effect with Gimp
094 **Windows**
Turn a monitor into a digital dashboard
096 **Macintosh**
Access your Mac anywhere
098 **Linux**
Use your smartphone as a webcam

MASTERCLASSES

100 **Raspberry Pi**
Stream live data to custom web pages

DOWNTIME

102 **Gaming reviews**
High-performance playtime
106 **Game changer**
Arma 3
110 **Retro**
The Amiga 500 bounces back
114 **Chip chat**
The less than serious news page

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HOW WE DO IT

Inside *APC*

Find out all about APC's editorial policies, test practices, how to read the benchmark results, and more.

"Championing technology doesn't mean we're unrelenting yes-men and -women, however, and APC aims to be as objective as possible in all our coverage."

APC is Australia's oldest consumer technology magazine – having been consistently in print for forty years, since our first issue way back in May 1980 – and we take that heritage and responsibility very seriously. While our focus is obviously on the personal computer the very definition of the PC has changed and shifted markedly since the early 1980s. As such, we touch on many other areas of tech, too, from smartphones and apps to peripherals, accessories, and beyond. We have two goals: to find the best modern tech and to help you make the most of it.

We're also an open church in terms of platforms. We know most people aren't wed to a single brand's products and use a variety of devices. And, like you, APC's journalists want to know what's good in tech – no matter what platform it resides on.

Independent reviews

Championing technology doesn't mean we're unrelenting yes-men and -women, however, and APC aims to be as objective as possible in all our coverage. That means identifying the best products from multiple perspectives – the best performance, best value and best features and, ideally, the products that offer the best mix of these three attributes.

As a matter of policy, reviews published in APC are not shared with product-makers prior to print. We will contact vendors under certain conditions; for example, if we have a problem testing a product that seems to indicate it may be faulty, or to invite a vendor to clarify how a particular feature works. If an APC reviewer has any potential conflicts of interest involving a brand, the review will always be assigned to another writer.

Labs testing

APC strives to conduct the most rigorous, objective scientific tests and benchmarks we can so as to make our reviews as unbiased as possible. We use a variety of tools and programs for this, including many freely available benchmark suites for assessing media encoding, general system performance including storage read and write speeds, gaming and battery life.

In most cases, for the benchmark results published in APC, you can assume that higher is better. There are certain tests that deviate from this rule where the opposite is true; in those cases, we've flagged the results with a note explaining as such.

We use both tables and graphs for displaying results; the latter offers better ease-of-readability, but tables are more compact, so we use these in most cases where thoroughness is preferred.

apc TESTBED

The current APC testbed used in the Labs for benchmarking all components. This testbed is updated as new and relevant technology comes on stream.

CPU	AMD Ryzen 7 5800X
Motherboard	Asus ROG Crosshair VIII Dark Hero
GPU	Zotac RTX 3080 Ti AMP Extreme Holo
Memory	Crucial Ballistix Sport DDR4-3600 2x16GB
Primary SSD	Adata S70 2TB NVMe
Secondary SSD	Samsung 980 Pro 500GB NVMe
Cooling	Nzxt X73 360mm AIO
Case	Thermaltake Core P8
Power Supply	Corsair AX1000

apc AWARDS

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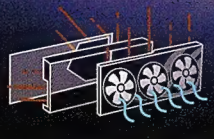
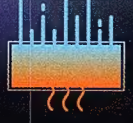


Vented Exoskeleton

Larger Axial-tech Fans

Massive Heatsinks



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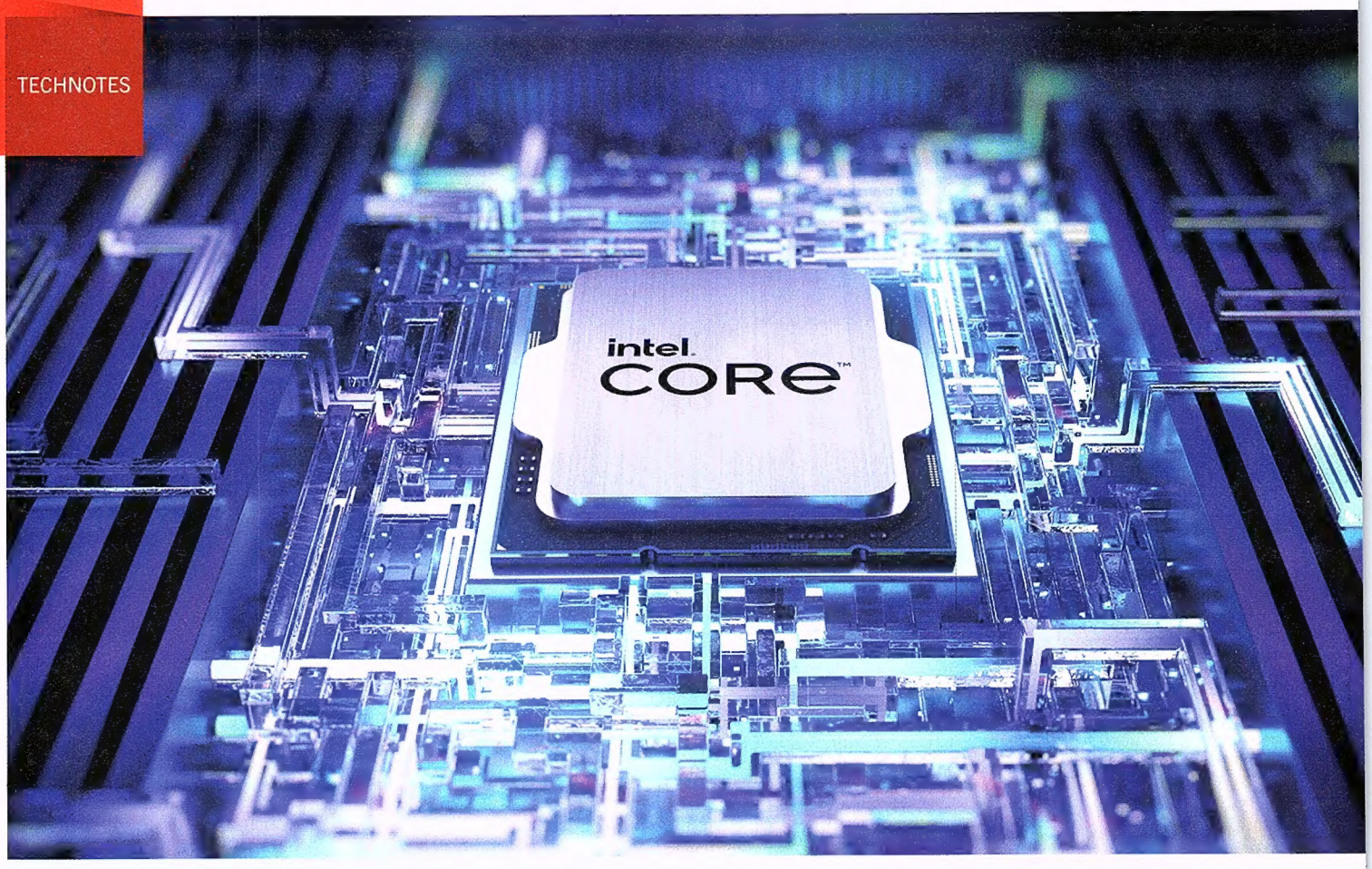


CPU

Intel launches Raptor Lake

Firing back at AMD's Ryzen 7000.

Intel has announced specs, pricing, benchmarks, and architectural details for its 13th-Gen Raptor Lake lineup, touting its flagship Core i9-13900K as the 'world's fastest desktop processor.' The lineup includes three new processors with frequencies that jump up to 5.8GHz, a new record for the mainstream desktop, and more e-cores, giving Intel the core count lead on the mainstream desktop for the first time since AMD's Ryzen arrived back in 2017. Intel also announced that the 6GHz version of the Raptor Lake is a limited edition model that will come to market later this year. This will be the first 6GHz desktop PC chip.

> "Intel claims the 13th-Gen Raptor Lake processors deliver up to 15 percent higher single-threaded performance and 41 percent more multi-threaded performance than their Alder Lake predecessors. "

Paired with a series of other advances, including bumping up the power consumption on lower-end models and the debut of the new Raptor Cove CPU cores, Intel claims the 13th-Gen Raptor Lake processors deliver up to 15 percent higher single-threaded performance and 41 percent more multi-threaded performance than their Alder Lake predecessors. The company also says that gaming performance has improved up to 25 percent on some titles.

If accurate, that means Raptor Lake will either match or exceed AMD's Ryzen 7000 processors that launched just prior to these, with the $1,149 Ryzen 9 7950X and $499 Ryzen 5 7600X both stealing the performance lead from Intel at their respective price points.

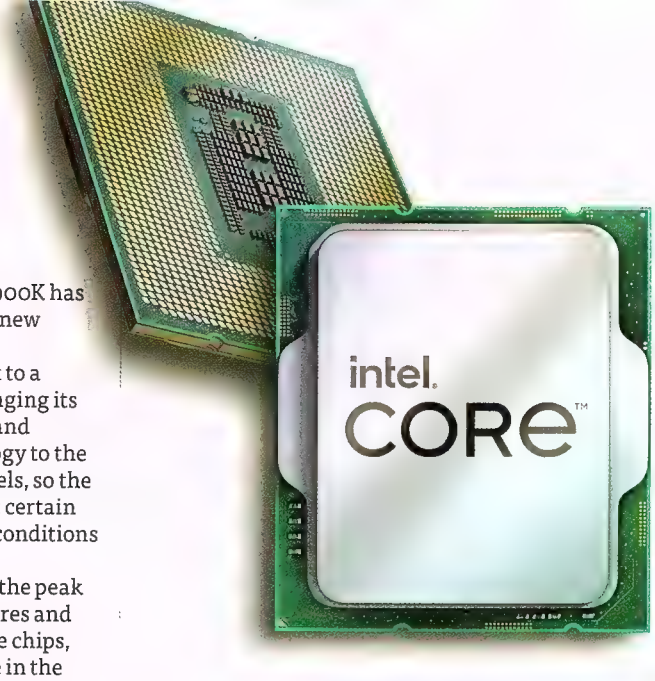
We have samples of the 13th gen chips in the APC Labs right now, and testing is underway and we'll have all our results and thoughts in the next issue.

Under the hood

The Raptor Lake K-Series Core i9, i7, and i5 chips span the flagship US$589 Core-13900K to the US$319 Core i5-13600K, but they're just the leading wave: Intel will eventually bring 22 Raptor Lake chips to market for desktop PCs, along with a separate lineup for laptops.

Intel has already announced that Raptor Lake will reach up to 6GHz, but it hasn't launched that chip yet. Intel confirms that this will be a pricey KS model, but we'll have to wait for more info. Intel's Raptor Lake focuses heavily on performance and now supports faster DDR5-5600 memory while maintaining support for value-option DDR4. Intel also employed a significantly improved 7nm process node and made several architectural advances, including fatter, faster, and smarter caches that significantly improve performance. Additionally, a new thread director baked directly into the new Windows 11 2H22 update will improve thread targeting, and thus improve performance with Raptor's hybrid architecture.

As before, Intel's Raptor Lake comes with a mix of both big performance cores (p-cores) for latency-sensitive work and small efficiency cores (e-cores) for threaded and background applications. The e-cores stick with the same Gracemont architecture as before, but the p-cores move from the Golden Cove design to Raptor Cove. As before, you can also opt for graphics-less F-series models to save some cash on the



three Raptor Lake chips.

The 24-core Core i9-13900K has the highest clocks of the new chips, with a 600MHz improvement bringing it to a 5.8GHz peak. Intel is bringing its Thermal Velocity Boost and Adaptive Boost Technology to the Raptor Lake Core i9 models, so the 13900K will have to meet certain temperature and power conditions to reach 5.8GHz.

While Intel has raised the peak frequencies for both p-cores and e-cores on all Raptor Lake chips, we see a 200MHz decline in the base clocks. That shouldn't mean much in practical application and is probably done to manage the TDP rating. Speaking of which, the 13900K has the same 125W Base Turbo Power (BTP) as before, but the Maximum Turbo Power (MTP) has increased by 12W and is now 253W.

The Core i9-13900K also has eight more e-cores than its predecessor, delivering much more threaded horsepower. The e-cores also come with a 400MHz increase to the peak boost, bringing them to 4.3GHz. Intel says that even though the e-cores use the same Gracemont architecture, changes to the caching policy and a few other fine-grained optimisations now yield the same IPC and frequency as the original 14nm Skylake cores, but at lower power. Notably, the e-cores give Intel the core count lead on the mainstream desktop PC, as AMD's Ryzen tops out at 16 cores with the 7950X.

AMD fires its salvo this month, and in the next issue we'll see what Intel's new weapons bring to the never ending CPU war. What a magical time!

Memory and mobos

Intel has increased its DDR5 memory support up to 5600MHz if you use one DIMM per channel (1DPC), a big increase over the prior 4800MHz speed with Alder Lake. Just as importantly, Intel increased 2DPC speeds up to 4400MHz, an improvement over the previous-gen 3600MHz. Intel will also continue to support DDR4 memory, which it predicts will coexist in the market with DDR5 until the end of 2024. This approach ensures a value option for Intel platforms, unlike AMD's all-in approach with DDR5.

Raptor Lake and Alder Lake will be compatible with new 700-series and existing 600-series motherboards. As usual, Intel will bring its Z-series (Z790, in this case) motherboards to market first, with the value-centric B- and H-series coming when it launches the rest of the Raptor Lake lineup.

The 700-series motherboards bring minor improvements over the 600-series, but Intel has increased the number of PCIe 4.0 lanes hanging off the chipset to 20, an increase of eight additional lanes. Intel also added support for one more USB 3.2 Gen 2x2 200Gps port, bringing the total to five. As before, the Raptor Lake chip itself supports 16 lanes of PCIe 5.0 and four lanes of PCIe 4.0 for a storage device.

Up and away

Finally, Intel also unveiled a few new overclocking features, including a new per-core overclocking feature that is now built into the company's XTU software.

Intel is also reviving its one-click overclocking feature, which previously surfaced as the Intel Performance Maximizer, but is now infusing it directly into the XTU software. Intel never released a one-click overclocking utility for Alder Lake, probably due to the complexities of automatically overclocking both the p-cores and e-cores, but the company has apparently solved those challenges. The 'new' one-click overclocking feature will automatically tune both types of cores.

It's clear that the competition between the Intel Raptor Lake and Ryzen 7000 lineups will be intense, and we've been hard at it with the Ryzen chips for this month's APC Labs Feature on page 50, and next issue we'll be overflowing with Raptor Lake results and opinions. ■

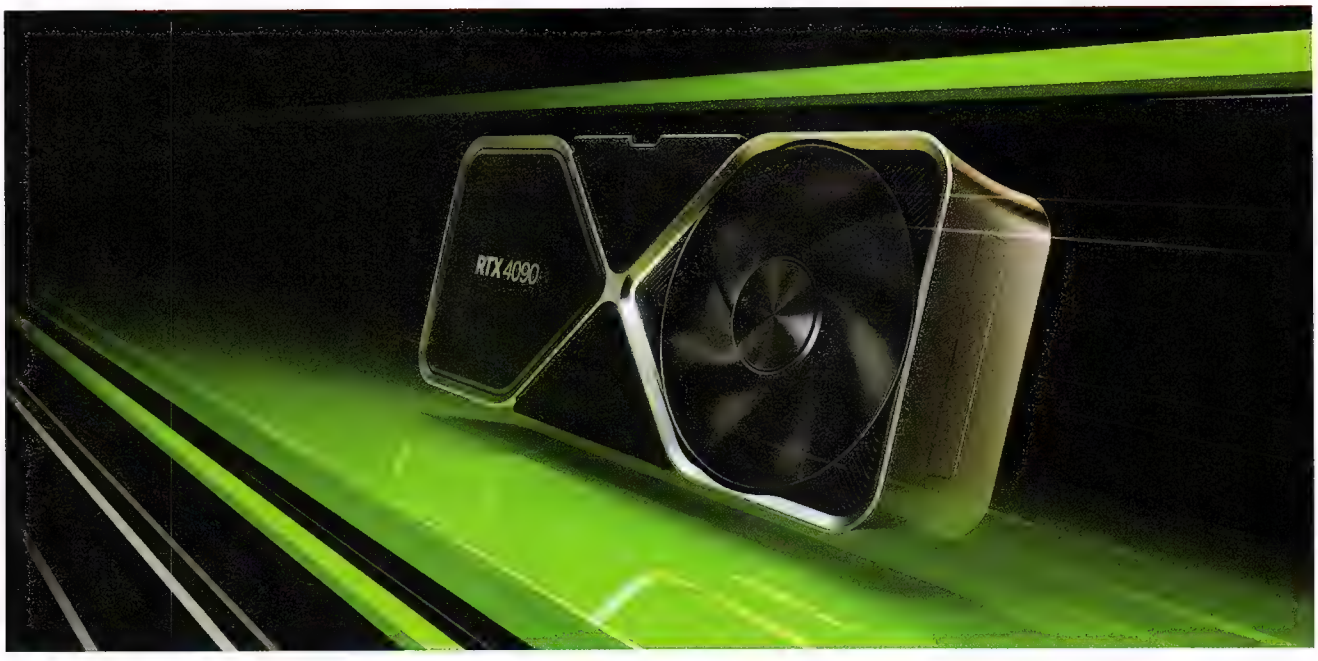
INTEL RAPTOR LAKE LAUNCH SPECIFICATIONS AND PRICING (WITH 12TH GEN FOR COMPARISON)

	Price (AUD)	Cores / Threads (P+E)	P-Core Base / Boost Clock (GHz)	E-Core Base / Boost Clock (GHz)	Cache (L2/L3)	TDP / PBP / MTP	Memory
Core i9 13900K / KF	$1,099 (K) $TBA (KF)	24 / 32 (8+16)	3.0 / 5.8	2.2 / 4.3	68MB (32+36)	125W / 253W	DDR4-3200 / DDR5-5600
Core i9 12900K / KF	$909 (K) $869 (KF)	16 / 24 (8+8)	3.2 / 5.2	2.4 / 3.9	44MB (14+30)	125W / 241W	DDR4-3200 / DDR5-4800
Core i7 13700K / KF	$769 (K) $729 (KF)	16 / 24 (8+8)	3.4 / 5.4	2.5 / 4.2	54MB (24+30)	125W / 253W	DDR4-3200 / DDR5-5600
Core i7 12700K / KF	$649 (K) $599 (KF)	12 / 20 (8+4)	3.6 / 5.0	2.7 / 3.8	37MB (12+25)	125W / 190W	DDR4-3200 / DDR5-4800
Core i5 13600K / KF	$569 (K) $529 (KF)	14 / 20 (6+8)	3.5 / 5.1	2.6 / 3.9	44MB (20+24)	125W / 181W	DDR4-3200 / DDR5-5600
Core i5 12600K / KF	$439 (K) $409 (KF)	10 / 16 (6+4)	3.7 / 4.9	2.8 / 3.6	29.5MB (9.5+20)	125W / 150W	DDR4-3200 / DDR5-4800
Core i5 13400 / F	TBA	10 / 16 (6+4)	3.4 / TBA	TBA	24MB	65W / TBA	DDR4-3200 / DDR5-5600
Core i5 12400 / F	$299 $269 (F)	6 / 12 (4+0)	4.4 / 2.5	-	25.5MB (7.5+18)	65W / 117W	DDR4-3200 / DDR5-4800

TECH BRIEF

Nvidia announces RTX 4090, RTX 4080

Say hello to Ada Lovelace.



Jarrod Walton
Jarrod can barely contain his excitement with all these big launches.

During the GTC 2022 keynote, Nvidia CEO Jensen Huang revealed the specifications for the RTX 4090 and RTX 4080, along with details of the Ada Lovelace architecture. Most of the most recent leaks appear to have been reasonably accurate.

The RTX 4090 will have 128 SMs with a 2,520 MHz boost clock, coupled with 24GB of GDDR6X memory running at 21 Gbps with a 384-bit interface. The memory configuration basically looks unchanged from the RTX 3090 Ti, which on the surface is basically correct. However, much like AMD did with RDNA 2's Infinity Cache, Nvidia will apparently be packing 96MB of L2 cache in AD102, compared to just 6MB of L2 cache in GA102 – that's not yet officially confirmed, but we see little reason to doubt it at this stage.

Core counts receive a greater than 50 percent boost over Ampere, with 128 SMs instead of only 84 SMs maximum – and there's still room for a 140–144 SM model in the future, perhaps a new Titan RTX, or at least a future RTX 4090 Ti. Core counts alone would provide a big jump in performance, but Nvidia has also tuned Ada to reach higher clocks, again similar to what AMD did with RDNA 2, and the result is the expected 2.5–2.6GHz boost clocks on the announced models. That's nearly 50 percent more than the RTX 3090's 1,695 MHz boost clock and 35 percent higher than the RTX 3090 Ti's 1,860 MHz – and Jensen says that Nvidia has hit clock speeds in excess of 3.0GHz with overclocking in its labs (hello, 800W custom RTX 4090 cards!).

Combined, the GPU shader counts and clock speeds yield the theoretical maximum performance figure. RTX 3090 was rated at 35.6 teraflops, RTX 3090 Ti bumped that up to 40 teraflops, and now the RTX 4090 pushes the needle up to 82.6 teraflops – more than double the compute, in other words. While teraflops alone can be a somewhat meaningless figure, it's still useful within similar architectures, and we're looking at perhaps the largest generational jump in performance that we've seen from Nvidia since the GeForce brand first came into being.

Stack fragmentation

It's not just RTX 4090, either, though some will undoubtedly be unhappy with the launch prices for the RTX 4080 16GB model. Nvidia did originally also announce a 12GB version of the 4080, and with it cut down specs that seemed to put it more in line as a 4070, and after the internet erupted with outrage Nvidia took the astonishing and unprecedented move of 'unlaunching' the RTX 4080 12GB. All those manufactured cards and printed boxes won't

GEFORCE RTX 40-SERIES SPECIFICATIONS

	RTX 4090	RTX 4080 16GB
CUDA Cores	16,384	9,728
Boost Clock	2,520 MHz	2,510 MHz
Base Clock	2,230 MHz	2,210 MHz
VRAM Capacity	24GB of GDDR6X	16GB of GDDR6X
Bus Width	384-bit	256-bit

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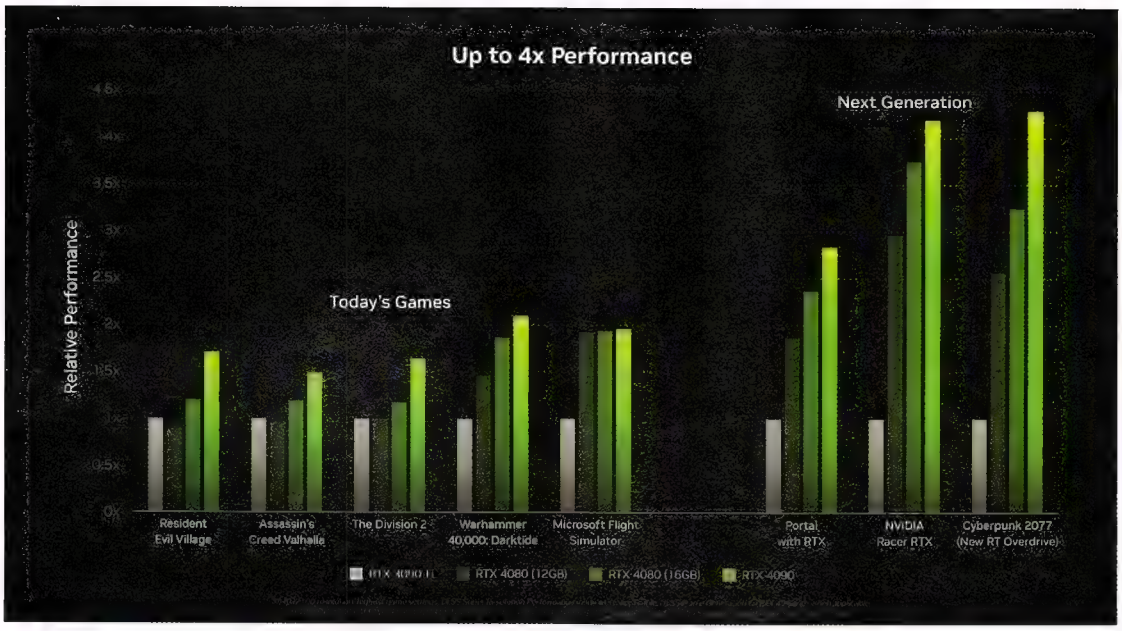

Nvidia is claiming significant gains over the last gen.

please the AIB partners at all. It's unclear what form the already-made 4080 12GB cards will take, and if they'll have more features disabled if they come back as a 4070 or 4070 Ti at some point in the future.

Nvidia hasn't stated which GPUs specifically are used in the various cards, though previous rumours suggested we were looking at three separate chips: AD102, AD103, and AD104. That still seems likely, again considering the differences in core counts, though it's possible the 4080 12GB will use harvested AD103 chips – if not now, then at some point in the future.

Note that Nvidia hasn't specified a launch date for the RTX 4080 cards. We're hopeful they'll still arrive in October, or perhaps early November at the latest. Given AMD now plans to announce RDNA 3 GPUs on November 3, that sets a pretty firm time limit. We'll probably see RTX 4080 GPUs arrive right before whenever AMD's RX 7900 XT retail launch occurs.

The bigger question will be real-world gains, of course, and the lack of substantial gains on memory bandwidth does raise some flags. However, keep in mind that when AMD basically slapped a bunch of L3 cache onto its RDNA design and then boosted clock speeds, cards like the RX 6600 XT were able to stay ahead of the previous generation RX 5700 XT, which had nearly twice the memory bandwidth – and that was with only 32MB on Navi 23. 96MB of L2 cache should give Nvidia cache hit rates of 50 percent or more, which means the effective memory bandwidth is doubled.

> "We're looking at perhaps the largest generational jump in performance that we've seen from Nvidia since the GeForce brand first came into being."

Architectural updates

Core counts and clock speeds have improved, but more importantly, there are architectural updates that can further boost performance. On the GPU shaders, Nvidia says Ada cores are up to twice the power efficiency. The shaders also support a new feature called SER, Shader Execution Reordering, which appears to mostly help with ray tracing performance but may also be useful in traditional rendering modes.

Moving on to the RT cores themselves, Nvidia has added more ray/triangle intersection hardware, allowing for up to twice the throughput in that area. A new opacity micromap engine also speeds up ray tracing for transparent textures. Similarly, the micromesh engine apparently can add geometry "richness" without the BVH build and storage cost – meaning, fewer triangles for the BVH but more for the final render. Nvidia says that the 3rd gen RT cores can generate the BVH structure 10 times faster than the 2nd gen cores, while using 20 times less memory – or five percent of the VRAM requirement.

Finally, the Tensor cores have been upgraded with Hopper's support of FP8 data types. That effectively doubles the compute throughput, assuming the workload can get by with the reduced precision. Note that the number of Tensor cores per SM appears unchanged, and throughput per Tensor core in FP16 operations remains the same. But the new Tensor cores are apparently a requirement for DLSS 3.

DLSS 3

While the architectural updates are great, Nvidia has also been hard at work on software updates. DLSS 3 is now official, with support for it coming in several of the games shown during the keynote, and probably many more on the way. Nvidia showed a performance boost using DLSS 3 vs. DLSSS 2 in Cyberpunk 2077 of 63 percent, presumably with similar visual fidelity on the final output.

The information provided suggests that DLSS 3 and the OFA can generate multiple frames out of a single source image by looking at the previous data. So in theory, it could potentially double the framerate, and in motion, it will probably help make games look smoother, though we do wonder how individual frame comparisons will stand up.

One of the big issues however is that DLSS 3 will only work with RTX 40-series (and later) GPUs. Game developers will basically need to include both DLSS 2 and DLSS 3 support if they want to cater to a wider set of gamers, and at that point they might as well add in FSR 2.0 and XeSS support as well.

Unfortunately, the cards most people are likely waiting for haven't been revealed. We've heard rumours of RTX 4070 and RTX 4060, but so far, we've only seen AIB RTX 4090 cards, not 4080, and not anything lower down the pecking order.

Jarrod Walton ■

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END USER

Stadia, and the risk of buying into new tech

Google is offering refunds for its failed initiative, but not all consumers are so lucky, writes Shaun Prescott.

Shaun is an Australian editor for *PC Gamer*, *GamesRadar* and *PLAY*, and writes for *APC*, *TechRadar* and more.

In the lead up to the November 2019 launch of Google Stadia, the internet was awash in op eds declaring the arrival of the game streaming era. Traditional consoles – the ones with powerful hardware under their hood, all the better to locally run games – were, for the umpteenth time, 'dead'. But rarely has a narrative backflipped so quickly, because the Stadia launched with a big ol' thud. Few people liked it; even fewer people presumably bought it.

It's immaterial in some respects, because Stadia – unlike Microsoft Cloud Gaming, or Nvidia GeForce Now – never launched in Australia. So when Google announced in late September that it was killing off Stadia (or at least, the consumer product associated with it) there were probably few Australians who sighed in relief, glad that they would get their money back. It's not that Google failed to provide a product because Stadia worked, it had games, and even some forthcoming exclusives. It's just that no one really used it, and anyway, the pricing system, and the vague sense of ownership of the games one purchased, were far more confusing than just, you know, buying a console.

Google is worth over a trillion dollars, so it's perhaps not surprising that with the closure of Stadia, the company has promised refunds on all Stadia hardware, as well as all Stadia software. That means, if you were an early adopter, you're getting a full refund on a technology you've presumably used for over three years (the lights are officially switched off on January 18, 2023). It almost makes you want to jump aboard every new technology of dubious promise, except of course, that's not the way it always works.

Take *Babylon's Fall* for instance, a live service action game released by Square Enix in February. The Platinum Games developed project tanked because it was mediocre. But in the event that you did buy it (it went for AU$99.95) at launch, you're shit out of luck, because Square Enix announced last month that the game's online functionality will shut in February. A piddling single player component will remain, but this was very much marketed as an ongoing, online experience. The question of refunds has not come up.

It's a sticky situation for a company asking for cash for an ongoing service that is sold on the premise that you'll continue to be able to use it (at least, for longer than a year). Ubisoft is an example of a game studio that handles this commendably: live service titles like *For Honor* and *The Crew 2* are hardly raging success stories, but the company keeps them alive anyway, because they said they would. Even if it may not be financially wise, it builds a sense of trust: if Ubisoft launches a live service game nowadays, you can buy it with some confidence that it'll be playable for a while. But for the most part, buying into any new tech product that requires ongoing love and care from its creators is a risk: if the product tanks, and you were unlucky enough to buy one, you might just end up with nothing.

Back to streaming, Microsoft has the right idea. Understanding that it's a new technology that needs time to persuade an audience, the company's streaming functionality is bundled into the Xbox Game Pass Ultimate subscription service that offers a hell of a lot of value even if you completely ignore the cloud. Will people continue to do so, though? As internet infrastructure gets better, it probably will gain a lot of traction – it's a democratising technology in many ways, allowing users to enjoy blockbuster games without forking out for expensive PC or console hardware. But Google clearly took the wrong approach.

What is the future of game streaming now that Stadia is dead?

Google Stadia dies in the crib, but the other major streaming services are taking very different approaches.

Once hyped as being 'the future of gaming', the Google Stadia game streaming service was officially, just three years after launch and before even making it to Australian shores. When game streaming first launched we did have some apprehension about its local capabilities considering the notoriously slow internet widely available in Australia. Interestingly though it wasn't technological limitations that made the game streaming service untenable... it was more likely a question of direction and management.

Early in 2021, Stadia abandoned its initial plan to create first party games under the former Ubisoft and EA Executive Producer Jade Raymond and shuttered its two dedicated Stadia studios. The move was pitched as a pivot to focus on encouraging third party developers to port games to the service. Soon after, however, *Bloomberg* reporter Jason Schreier quoted sources within Google that said it was having to pay exorbitantly to pull titles across to Stadia. "Tens of millions of dollars, the budget of some major games, per Stadia port", reported Schreier.

The service only offered a limited number of titles and no exclusives at launch despite an aggressive marketing campaign, which meant that the underwhelming number of subscribers were disappointed from the outset. If that wasn't enough, subscribers were also resistant to the model that required users to buy games at full price when you would only be able to play them by continuously paying for a Stadia subscription.

Fortunately, the game streaming speace is still very new and there's plenty of alternate options available in Australia that each take a different approach.

Xbox Cloud Gaming (Beta)

Microsoft's offering is perhaps the closest to the Netflix model of streaming offering remote game processing and the option to play a catalogue of games bundled into the one $15.95 per month subscription. Xbox has partnered with Samsung for direct apps on its 2022 smart TVs that mean you can connect an XBox controller straight to your TV and play a decent array of popular Triple A titles with a 5G or 20Mbps+ internet connection.

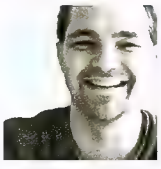
Nvidia GeForce Now

In Australia, GeForce Now is powered by the Perth-based company Pentanet and offers a slightly different way to play. Your monthly membership fee here gives you access to powerful computers that you can play a wide range of games you might already own on a system without beefy graphical capabilities. GeForce Now offers free trials and memberships from $3.49 per month and syncs your Steam, Epic, GOG, Origin or Ubisoft Connect game libraries to give you access to any titles you already own. You can play on LG and Android TVs (as well as many other devices) by connecting a Nvidia Shield, Xbox or PS5 DualSense controller.

Steam Link

If you're already a PC gamer with a powerful PC, you can get a similar experience by using the free Steam Link software to stream games from your PC to other devices on a local network or even play remotely over the web. This service ties into Valve's Steam Deck that will allow you to take your games anywhere you want once it launches locally. Steam link already has apps that you can freely use on your Android or Samsung TVs.

Joel Burgess ■



Joel is one of the senior journalists on *APC* magazine and apart from being the resident laptop, monitor and fitness tech geek, he's also pretty into surfing his local Sydney beach breaks when he's not in front of a screen.

TWO BITS

Where Arc, though?

Intel's Arc graphics cards are curiously absent from Australian shores.

Chris has been elbow deep in PCs since before the turn of the millennium, and he wouldn't have it any other way.

Though you mightn't have noticed in Australia, Intel has released its first Arc graphics cards. International reviews of the Arc A770 and A750 went live on the 6th of October, but at the time of writing (in mid-October) there was no sign of the cards in the Australian market. That's a real shame. I, for one, am particularly interested in Arc. I really hope it succeeds, and hope the next generation Battlemage, Celestial and Druid generations (B, C and D) really can compete with Nvidia and AMD.

The general consensus seems that Arc A770 is actually a competent mid-range graphics card. It's got a good feature set, including 16GB of VRAM, an excellent video engine, good price/performance and its DLSS/FSR competing XeSS is an open standard that seems to be working well, even if it's not widely supported yet. Yes, it's true, they have been delayed, they can't compete with high end Nvidia and AMD cards and the drivers reportedly need some work, but it's a first attempt. Well, not exactly the first (recalling Larrabee) but it's the first in a long time.

Arc has been an easy target for some IT journalists and the general public alike. Fanboyism remains a scourge of the internet and social media, as if people need to justify their purchases in their own minds. Mockery along the lines of 'Oh no! it can't even compete with a 3080, let alone a 4090' entirely misses the point of Arc. I'm looking forward to seeing how it matures.

> "The desktop graphics card market has been through a tumultuous couple of years."

Not everyone needs or wants $2,500 graphics cards. The RTX 3060 is a few months away from its second birthday, while the RX 6600 is well over a year old. The mid-range market needs a shakeup. Come on Intel, let's get those Arc cards here in Australia. Perhaps in some prebuilts first, with a test run of retail cards.

The market is better for consumers when there's competition, and a huge company like Intel has the resources and talent to make it work. The gaming market is one thing, but GPGPU is ever expanding. Just look at how Nvidia and AMD talk about machine learning, AI and big data. I can't see Intel giving up on Arc easily, as it has applications well beyond just being a gamer card.

The desktop graphics card market has been through a tumultuous couple of years. The mining boom, bare shelves and exorbitant prices made it a difficult time to be a PC gamer. Now the mining boom has ended, the PC market is in the midst of a dramatic downturn and the first RTX 40 (and future RX 7000) cards are very expensive. There's a window for affordable alternatives. Intel Arc may be able to capture some of this market.

We've reached out to Intel Australia. We know they are keen to bring the range to Australia. APC has registered its interest in reviewing at least one Arc card.

If and when we are able to bring a review to you, we'll be approaching it with an open mind. If the driver is up to par, and it's priced right, It'll have a good foundation to begin with.

Remember. There are no bad graphics cards, only bad prices. Arc has a chance to carve a place for itself in the Australian market. And I welcome it. ■

Chris Szewczyk

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TRADE CHAT

Ever upwards

Plenty Moore where that came from...

Jeremy Laird
Six raw 4K panels forbreakfast, laced with extract of x86... Jeremy Laird eats and breathes PC technology.

What happened to the end of Moore's Law? Not long ago, it was game over for shrinking transistors and ever more powerful and cheaper computer chips. But now, TSMC is about to start banging out 3nm wafers.

Intel also insists it will regain process node leadership before the end of the decade, which implies at least two or three process shrinks in the next five years. Turning sand into high-performance silicon chips containing billions of individual components is one of the greatest technical achievements in human history. But for a while in the 2010s, it looked like progress was going the same way as supersonic travel. We'd hit a wall. But TSMC upped its game and the rest of the industry is being dragged along with it.

> "Turning sand into high-performance silicon chips containing billions of individual components is one of the greatest technical achievements in human history. "

In terms of truly mass-produced computer chips for commercial consumption, only TSMC, Intel, and Samsung factor when it comes to operating right at the cutting edge. While only these companies can produce the most advanced chips in retail volumes, several others are critical in enabling that to happen. The best known is ASML, the Dutch outfit that makes the EUV or extreme ultra-violet lithography machines used by the big three to etch the tiny features into the silicon wafers.

Just as important is IMEC, a research outfit that helps the big boys advance their process tech. Earlier this year, IMEC unveiled a roadmap reaching right out to 2036. IMEC isn't explicit about it, but it's clear its nomenclature aligns with TSMC's commercial nodes, with N7 or 7nm placed in 2018 and N5 or 5nm in 2020. Predictably, IMEC has N3 inked in for later this year.

But it's the rest of IMEC's roadmap that's really exciting. IMEC reckons 2024 will see a new 2nm node, with a so-called A14 node in 2026. A14 refers to 14 angstroms, equivalent to 1.4nm. The A10 node follows in 2028 with new nodes slated every two years up to 2036 and A2, the same as 0.2nm.

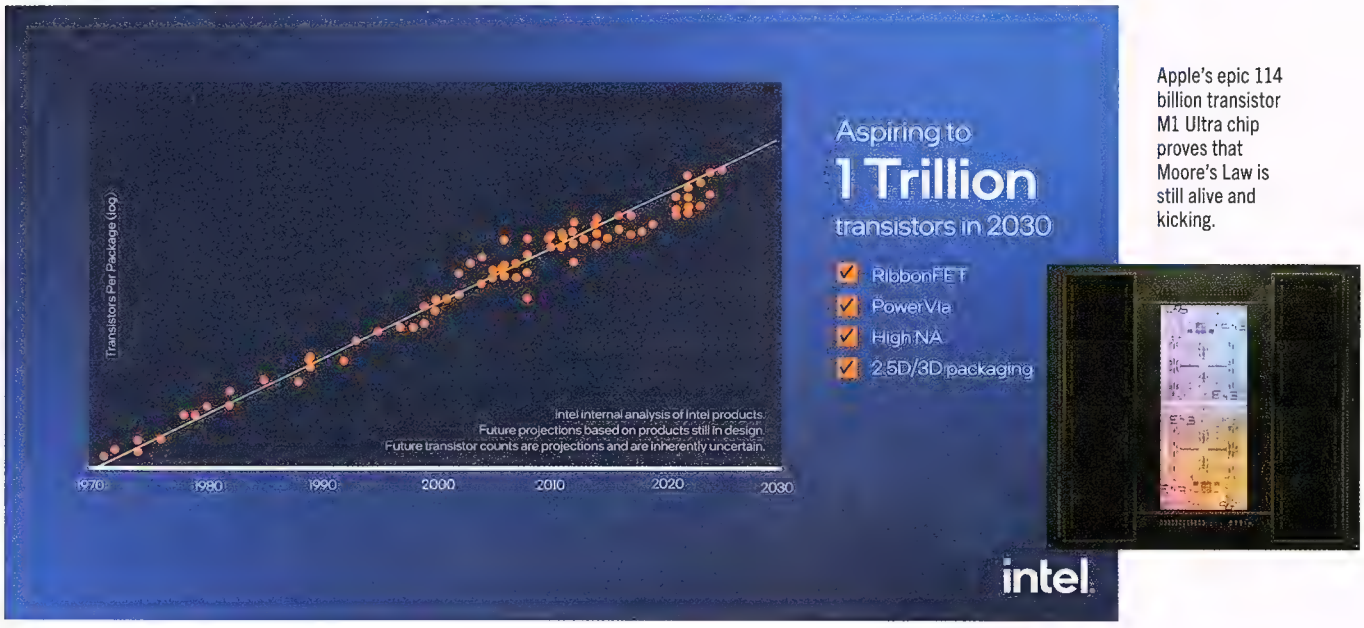
Of course, none of these measurements, in nanometers or angstroms, directly correlate with the actual size of chip features. But the point is that IMEC can see all the way to 2036 and thinks it can deliver nodes with significant feature size shrinkage every two years over that period, keeping Moore's Law on track.

IMEC's roadmap includes several new technologies that will help achieve that scaling to 2036, many of which have already been developed. One example is the CFET or the complementary field-effect transistor. It's the next evolution of the latest GAAFET (gate all-around field-effect transistors) that TSMC is set to use for its 3nm node and Intel is planning for its own A18 node.

In 2036, an even more exotic transistor structure is planned, known as atomic level sheets or 2D transistors. Created using tungsten disulfide to form self-assembly 2D structures just one atom thick, you'd think the industry will have hit the wall. But then rumours of Moore's Law demise have been exaggerated in the past.

Don't ask me how they will do it, but my money is on the advances continuing beyond 2036. By then, today's 5nm chips with their billions of transistors will look like a 90s pocket calculator does today.

Jeremy Laird ■

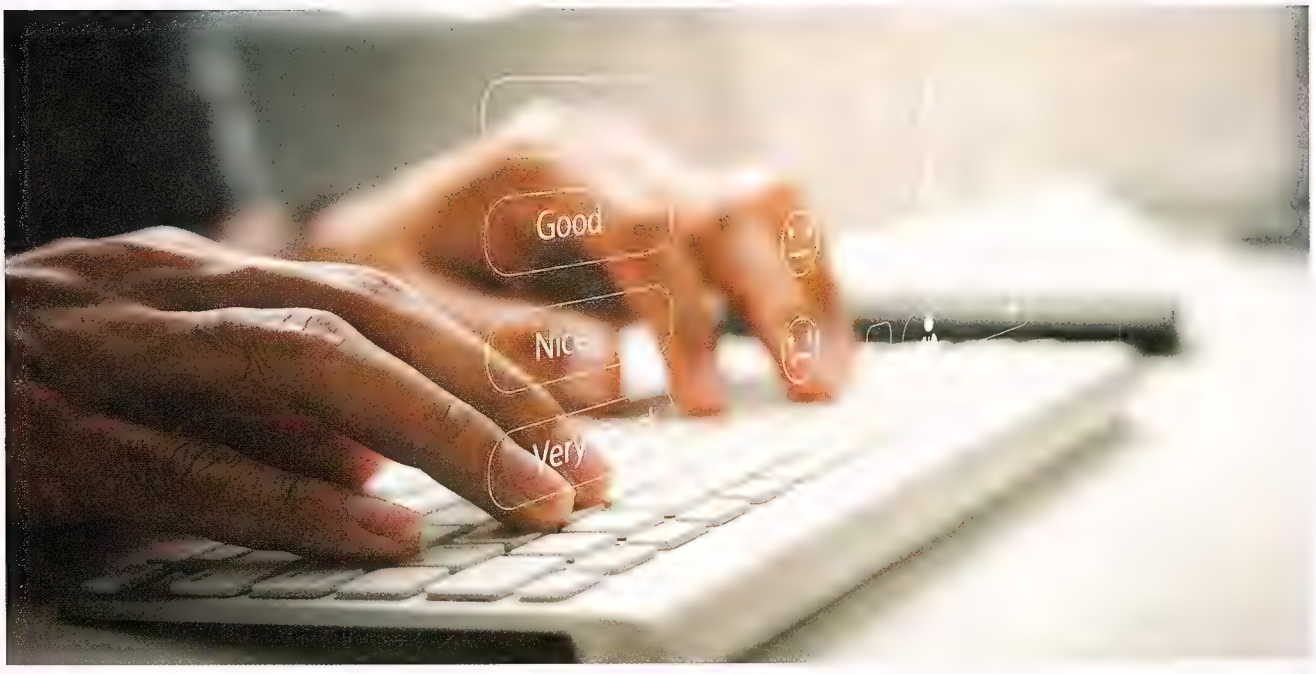


Apple's epic 114 billion transistor M1 Ultra chip proves that Moore's Law is still alive and kicking.

ONE MORE THING

Adequate is all you're getting

Jon Honeyball is decidedly unsatisfied with the whole customer satisfaction business.



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I'm getting increasingly annoyed with spam email. I don't mean the old-school nonsense telling me that some noble person has decided to leave me $10,000,000, and they need my help to get the money out of the country.

No, I'm talking about the stuff you get once you have had some legitimate contact with a business. Buy something online and the new normal is you getting an email in the following days asking you to rate how much you were exquisitely thrilled by the whole process.

If you dare to not reply, you can expect a whole raft of subsequent emails chiding you that "since we haven't heard from you, we thought we'd harass you once again" in the hope that you will provide feedback.

I can understand why a vendor would like to get a good rating, especially if it's a hotel or restaurant. It helps some users when trying to find somewhere to eat or stay. It doesn't really help anyone when I am asked to rate the experience of delivering the half dozen Ethernet cables that I needed.

I don't respond to these. I carefully check the "From:" address, and if it's not the same as the main receipt address for the company, it goes straight into the spam list. I will, as a matter of course, hit the "Unsubscribe" button. Assuming that there even is one.

I have come to the conclusion that there is a conspiracy going on here, and I point the finger at the companies who offer this sort of customer satisfaction measurement tools. In the past, it was quite simple – a few questions like, "Was it okay?", "Do you get it on time?", "Would you buy from us again?"

Now, however, it has turned into a click-by-click medical examination of the entire process. Was the delivery driver cheerful? Was he cheerful enough? Too cheerful? How was the handing over experience? The colour of the box? Were the bubbles in the bubble wrap loud enough when you popped them?

And worse still, there has been a complete misappropriation of descriptions. The industry has shifted from finding out if something went wrong to a whole kaleidoscope of happiness on a 1 to 10 scale, from deeply unhappy to utterly delirious.

In a seemingly desperate attempt, the metric has shifted from "adequate" to "delighted". There is no such thing as a delightful delivery experience, unless the driver decides to offer services above and beyond. I ordered the product, I knew what I was expecting, it was delivered on time. The item wasn't broken, lost, soggy from being left in the rain, and it didn't appear to have been drop-kicked into the delivery van. That is a perfectly adequate experience. There is no such thing as a "10 out of 10 delighted" experience to getting what I ordered, on time and in working order.

I can be delighted about the salmon sashimi in a restaurant. I cannot be delighted about my UPS delivery, even though our local chap is unfailingly polite and cheerful.

This customer feedback industry has got out of control. Now, who can I tell that I am very unhappy with the whole experience?

Jon Honeyball ■

Jon Honeyball
Jon hopes you are satisfied with this column and will recommend it to a friend.

"It doesn't really help anyone when I am asked to rate the experience of delivering the half dozen Ethernet cables that I needed."

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FUTURES

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The QUANTUM INTERNET is on its way

A pair of key experiments show how quantum tech could add unbreakable security to the internet. Nicole Kobie reveals what you need to know about the quantum internet.

You may not have realised it as you were doom-scrolling through news about pandemics and politics, but 2020 was the year of the quantum internet – all thanks to a pair of experiments that suggests this futuristic networking technology could indeed be possible.

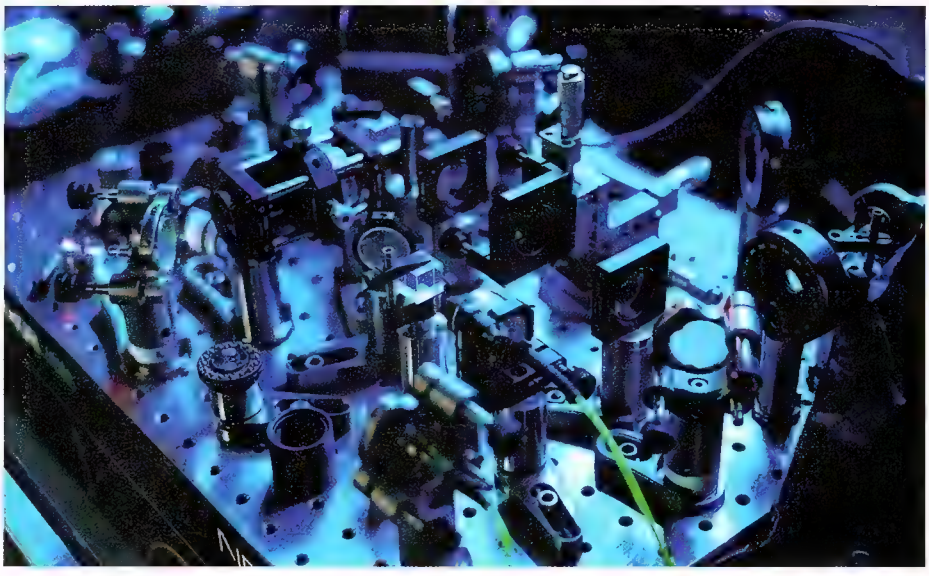
It's not a new idea, with the US military's Defense Advanced Research Projects Agency (DARPA) setting up the first quantum key distribution network in 2003 and experiments in quantum teleportation going back to 1997 at the University of Vienna.

So what was so special about 2020? In February, scientists from the University of Science and Technology of China published a paper detailing a 1,200km quantum link with the Micius satellite, the longest yet. A few months later, in September, researchers at the University of Bristol revealed a way to scale this nascent tech beyond a single connection.

"When I started, getting quantum computing to work between two people was a big deal," said Siddarth Joshi, a research fellow at the University of Bristol's Faculty of Engineering. "Now we are getting it to work between larger and larger networks. And satellites, when I started, were a dream. Now there's a satellite in orbit and we're building other satellites."

Plenty of other researchers are investigating this area, with notable work at the University of Innsbruck and the University of Chicago, and a Delft University of Technology project to build a network between four cities. But, in 2020, these two sets of results marked a step forward for the tech.

"We can do a lot of interesting things on a one-to-one basis at a near distance," said Dr Harun Šiljak, assistant professor at the School of Engineering at Trinity College Dublin. "But when we try to stretch it over hundreds of kilometres, or if there's dozens of participants, things get ugly. And 2020 brought us both an advancement in trust-free communications over distance with the Chinese, and in terms of scaling with what's being done in Bristol."



The Bristol experiment is a key step towards quantum cryptography.

How it works

What is the quantum internet? With the standard internet, packets of data are sent via networks and reassembled at the other end. For added protection, those packets are now largely encrypted.

Quantum internet takes advantage of inherent connections between quantum bits, or qubits. That link between particles is known as entanglement, and whatever change you make to one entangled particle happens to the other. Rather than sending packets of data, the quantum internet sends an entangled light particle down a fibre-optic line, holding back the particle that's linked to it. They now have a connection for sending data. Meddle with that and it's immediately obvious, as any attempt to measure a quantum state automatically changes it – it's a rule of physics – making it impossible to intercept the transmission.

Qubits can act like binary but better: rather than a one or a zero, a qubit can be either, both or neither, making it possible to encode even more data. Shove one of those qubits into the particle you held back, and the data will show up in the one you sent down the fibre-optic cable.

That's the simplified version, and it's so much more complicated than that in reality – not least because physics is hard and particles of light are finicky at best.

We've already seen the first wave of this technology, which uses the property of entanglement to share something similar to encryption keys, called quantum key distribution (QKD).

The first quantum key distribution was in 2004 for a bank in Austria, and commercial QKD services are already on offer from companies such as ID Quantique and MagiQ technologies. QKD is one aspect of the quantum internet, but now there's work sharing even more information over longer distances to more

people. "The big advantage of quantum communication is that it's far more secure than anything else," Joshi said. The encryption we use to protect our communications now is difficult to decrypt, but not impossible – and will become simple when quantum computers arrive. "If somebody has a sufficiently powerful computer, they can solve the problem and be able to decrypt it very easily," he said.

After all, anyone with a fast PC today could decrypt communications from 30 years ago, if they had access to them. "If you want to keep data secure in the long term, you want something like quantum communication, where it's not based on a problem that is difficult to solve, but a problem that is impossible to solve – it relies on the laws of physics to ensure that a process is one way, like burning a message on a piece of paper."

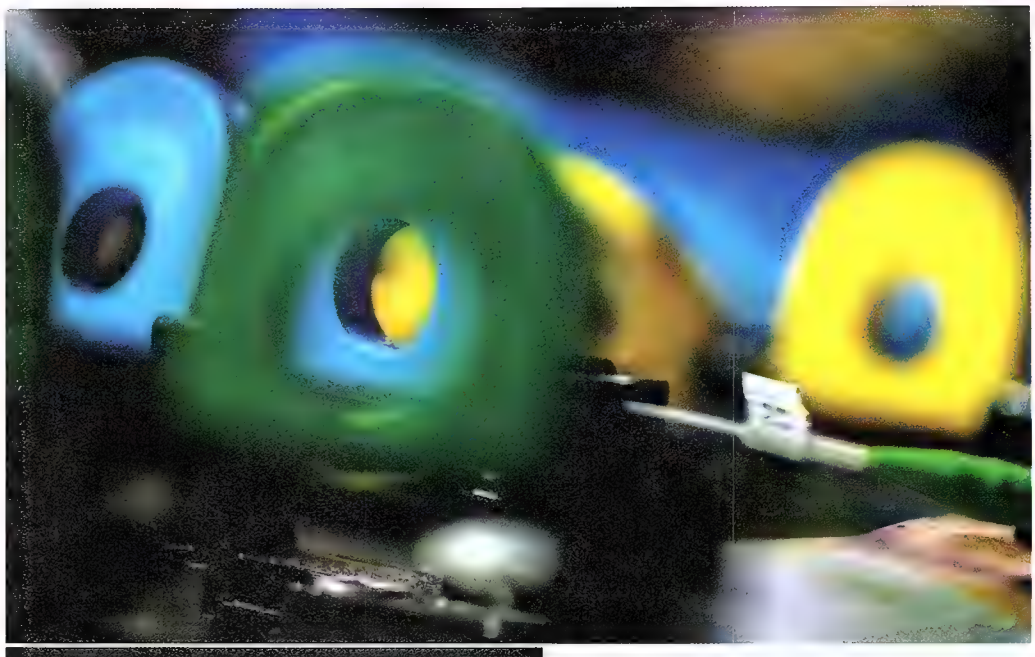
That said, Joshi notes that transmission is only one aspect of security or privacy: if the person you're sending it to takes a screenshot of the message and posts it to Twitter, it doesn't matter if it was sent using 30-year-old encryption or quantum networking.

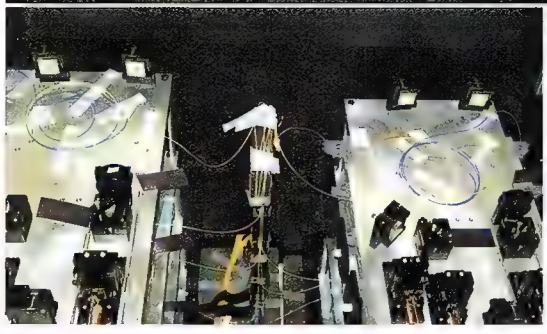
The Chinese satellite

With both experiments, the issue to overcome wasn't with the idea of the quantum internet but scaling: first in the distance covered and, second, with the number of participants.

Let's start with distance. This is a problem because of attenuation; the signal decays and that can cause the quantum properties to fade. "You're trying to distribute something that's very fragile over a large distance, and you're doing it through fibre-optic cable," Šiljak said. That's true for traditional communications as well, with repeaters in place to boost the light signal and send it forward, but the physics aren't the same for quantum signals, he added.

One way of avoiding that issue is line-of-sight transmissions, which works with satellites. In 2016, China launched the world's first quantum satellite, named Micius, as part of the Quantum Experiments at Space Scale (QUESS) project – at the time, it was dubbed by *Popular Science* as a "satellite for the post-Snowden age". It's widely assumed that China's focus on satellite quantum communications is due to potential military benefits.





Top: In the Bristol test, light is distributed into optical fibres and each fibre is adjusted.
Above: The network in operation,with the receiving hardware for all eight users.

Indeed, this style of quantum communications only works if you trust who runs the satellite. "That's a major thing," Šiljak said. "Back when Micius was just launched... every participant in the conversation had to trust the satellite – you established a connection with the satellite, and agreed on the keys... we pretty much trusted that the satellite on our side is not managed by some entity that we don't trust."

That's no longer the case, with the key exchange happening between the sender and receiver via the satellite, but without the satellite having the means to intercept the data. "That was a big advancement, since that's what we've been imagining with the quantum internet," Šiljak said. "And it's finally happening."

While this means quantum satellites could work, it doesn't solve the attenuation issues for fibre optics, with researchers in Chicago building a 50km fibre-optic quantum loop to investigate the problem. "If we want anything resembling the internet, we need quantum repeaters," Šiljak said. "That's the holy grail we're pursuing."

Every user has a single glass fibre connected to a source of entanglement.

More people

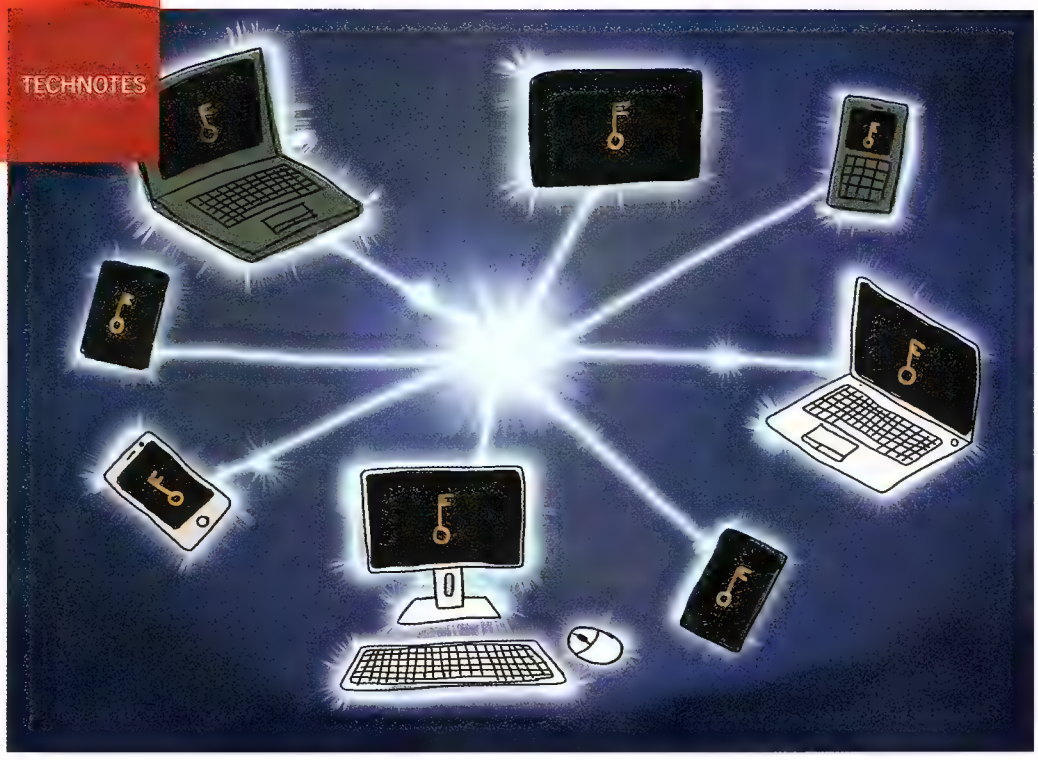
The University of Bristol project, part of the Quantum Communications Hub and UK National Quantum Technologies Programme, scaled up the number of people in the network, connecting eight via quantum communications. It's not many, but it's a start.

Previously, one of the challenges with quantum networks was the need for both a transmitter and a receiver, rather like the walkie-talkies you may have had as a child. One set let you speak to a friend, but to include a third friend, you'd need another set. "Now imagine that scaled up to 100 people," Joshi said. "You'd have to have 99 walkie-talkies."

The other way to manage such communications is to have a trusted node. Everyone on the network shares their message with the node, which in turn doles it out to the recipient. That's what Joshi's project managed using an idea called multiplexing, which means that everyone on the network has a quantum-entangled state with everyone else. He compares it to the internet, where you have one device and one internet cable or Wi-Fi connection, but that setup means you can receive signals from anyone. "We were able to do this across the city of Bristol, so it's not just a lab demonstration," he told us.

However, there's a limit to this technology: go beyond 50 to 100 people on the network and it won't work. This time Joshi compares it to a home Wi-Fi network, which can normally only connect 32 devices. "The way around that is you have to figure out how to connect one router to another router, and start building larger and larger networks," he said. "That is exactly what our next step is."

It won't be easy. Not only will adding users increase the network complexity, but it's unclear exactly how the quantum internet will be



A quantum network provides perfect encryption keys (by Holly Caskie).

used in the future, so Joshi and his team don't know exactly what to optimise for. "Because quantum networks are such an emerging field, you're trying to create networks that are as flexible as possible," he said.

Other challenges

Another major challenge for the quantum internet is memory. "The fundamental principle of memory, of something that could store quantum information, is as yet unsolved," Šiljak said. "It's another major issue and it touches both on computation and communication."

Another hurdle relates directly to Šiljak's own work: connecting the existing internet to a quantum version. At the core is the idea of reversible computing, in which computers don't lose information when performing an operation. "Imagine that you have a computer that is summing two numbers. You put in two numbers and you get an output third number – but you aren't able to reconstruct the inputs from the outputs," he said. "If the answer is seven, you have no idea which two numbers were used."

It gets a bit weird here: by losing that information about the inputs, power is dissipated. It's like entropy, but for computers, Šiljak says of the theory. "If your computer forgets things, it has to spend more energy than a computer that does not," he explained. When Šiljak started working on that idea, the one example that kept being raised was quantum computers, which have to be reversible by their nature.

What does that have to do with interconnects? While traditional computers aren't reversible, quantum ones would be – and for them to interact there needs to be a structure in between them. Building that won't be easy, though.

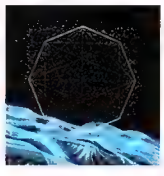
When will the quantum internet arrive?

Quantum internet won't replace the existing internet but be an added function. Joshi believes it will start being adopted for specific use cases by government and financial institutions to keep backbone connections secure. That work has already started, with Joshi working with commercial partners, but could take a decade.

It will take much longer for a quantum network to connect all the way down to your house, and will require optical fibre to do so. "We might see limited applications that to an extent resemble our electrical computer network, but not necessarily the internet," Šiljak said.

That may make the idea of a quantum internet sound unlikely; after all, so far, it can connect two people sitting nearby. But that's exactly how the internet itself began, argues Joshi, "connecting just two universities in CERN". In particular, the first communication was sending simple messages. "That's exactly how the quantum internet is starting right now," he said. "We have good analogies from the past, we've done this all before."

Indeed, Joshi looks to optical fibre rollouts as another analogy from the past to explain how quantum internet will arrive. First, it will link data centres and other important back-end sites. Then it will filter down in stages, eventually reaching individual homes. "That's the kind of adoption curve we're looking at here as well," he said.



An artistic depiction of the quantum network (by Anta Bucevic).

Security for all

Perfectly secure communication has a clear use case for the military, financial institutions and governments, who not only need to know a message hasn't been read but also have the money to run cutting-edge systems.

However, the researchers behind these projects believe the quantum internet will be for everyone – and should be. "I would say that privacy and security are fundamental rights," Joshi said. "One day this is going to be universal, everybody wants this."

In fact, he argues that in the long-term, it's personal data that matters the most. A financial transaction, such as with your bank, is only of interest to hackers to hijack in the moment, not decades down the line. "You send money, it's received on the other end of the globe within seconds," Joshi said. "If you have a sufficiently complex problem that a current computer cannot hack in a few seconds, that's fine.

"But what do you want to really keep private? Your personal details, your medical information. You don't want that information to leak out 30 years later and embarrass you," he added. "That is where quantum communication really shines."

Of course, governments have long fought against end-to-end encryption for private individuals, arguing that it gets in the way of prevention and investigation of serious crimes such as terrorism. We can expect them to do the same here. "There'll be two competing interests," Joshi predicted. "The government will want the technology to exist in its unmodified and perfectly secure form, and also want the technology to exist such that they can snoop on everybody else."

This won't just have a niche application, Šiljak says. If quantum internet can be built in an affordable, scalable way to be used by the military or fintechs then it shouldn't be too expensive or complex for everyone to use.

"I don't see a scenario in which it remains a closed technology," Šiljak said. "Once we have it, it's going to be distributed globally." ■

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From $2,999, apple.com/au

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NEW ENTRY

DELL XPS 15 (2022)

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From $2,924, dell.com

APPLE MACBOOK AIR

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From $1,899, apple.com/au

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$2,299, asus.com/au

BUSINESS LAPTOPS

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The updated XPS's headline features include a notably more powerful Intel 12th generation CPU, an optional OLED touchscreen panel, an integrated glass touchpad palmrest and a neat capacitive touch bar. A powerful luxury laptop that's up there with the very best.

$2,339, dell.com/en-au

ALTERNATIVES

HP ELITEBOOK 840 AERO G8

HP's premium range of laptops is worth the extra for its top-quality screen, and it's backed up by HP's Wolf Security and a slim, all-metal chassis.

$2,209, hp.com/au-en

LENOVO THINKPAD X1 CARBON GEN 9

A business laptop with heaps of luxury, especially if you choose the top-end model with a 3,840 x 2,400 screen.

$2,959, lenovo.com/au

DYNABOOK PORTÉGÉ X30W-J

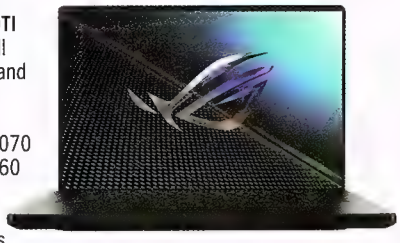
This 2-in-1 convertible is ludicrously light and slim, and offers a quiet keyboard, great performanc, ports a-plenty, and a nice touchscreen.

$2,083, anz.dynabook.com

GAMING LAPTOPS

ASUS ROG ZEPHYRUS M16 (2022)

I9-12900H AND AN RTX 3070TI



2022 will see an update for all mainstream gaming laptops, and Asus is first to jump in with a 12th gen Core i9 CPU to give 16-core support to the RTX 3070 Ti graphics (a Core i7/RTX 3060 variant costs $2,999). While battery life is only average at around six hours, this laptop's final triumph is fitting a gorgeous 16-inch screen into such a compact chassis.

$4,499, asus.com/au

ALTERNATIVES

LENOVO LEGION 5I PRO (16IN)

A great-value gaming laptop that's extracts the most from its powerful components. We really love the keyboard, too.

From $2,649, lenovo.com/au

ASUS ROG STRIX SCAR 17 SE

An extremely high performance esports gaming laptop that was a good 15 percent faster than any other laptop we had on file.

$5,799, asus.com/au

ASUS ROG ZEPHYRUS G14 (2022)

A powerful gaming ultraportable that lights up for both work and play. The AMD CPU and GPU balance well.

$3,499, asus.com/au

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From $1,099, microsoft.com/en-au

ALTERNATIVES

LENOVO YOGA SLIM 7 PRO

A powerful, well designed ultrabook with an awesome OLED screen for a good price. The original 2-in-1 bends into a new clamshell shape.

$1,699, lenovo.com

HP ENVY 13 (2020)

It may not be the world's most exciting laptop, but the Envy 13 is a compact and forward-looking machine that's ideally suited to these homeworking times.

$1,699, store.hp.com

NEW ENTRY

HP PAVILION 14

This slim 1.4kg laptop is a superb choice for anyone on a tighter budget. it struck an excellent balance between speed and battery life – around ten hours.

From $999, store.hp.com

CHROMEBOOKS

ASUS CHROMEBOOK FLIP CX5

The best big-screen Chromebook we've tried, with a bright 15.6in Full HD display with decent black levels and surprisingly rich colours. And it's a good specification for the price, with a Core i3 processor, 8GB of RAM and a 128GB SSD in tow.

$1,213, asus.com/au

LENOVO FLEX 3 CHROMEBOOK

This isn't the most powerful Chromebook, but students need reliability more than power – especially if they're only really using it for homework, note-taking, and perhaps the occasional bit of Netflix.

$484, lenovo.com/au

LENOVO IDEAPAD DUET

The Chromebook answer to Microsoft's Surface tablets, this is a seriously versatile device – albeit not the speediest (although we never found it to be painfully slow while carrying out everyday tasks). For this price, and with a 16hrs 14mins battery life, the Duet is a great choice.

$899, lenovo.com/au

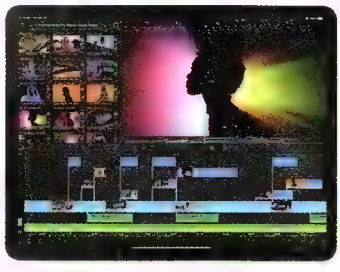
TABLETS

APPLE IPAD PRO 12.9IN (2021)

M1 POWER IN YOUR PALM FROM $1,199

Blurring the boundaries between laptop and tablet like never before, the M1-powered iPad Pro 12.9-inch is every bit as fast as we expected – and the "Liquid Retina XDR" display is simply phenomenal.

From $1,649, apple.com/au



APPLE IPAD (2021)

Apple performs its usual trick of upgrading just enough to keep the iPad affordable and up to date, without treading on the toes of its more luxurious stablemates. The big bezels remain, but a faster processor, more storage and improved camera all add to its appeal.

From $499, apple.com/au

SAMSUNG GALAXY S8 ULTRA

The Samsung Galaxy Tab S8 Ultra is an enormously impressive tablet. It makes a fantastic first impression with its gorgeous screen and thin body, and is great for multitasking. If you want the best Android tablet going, there's no question at all that this is it.

$1,499, samsung.com

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34-INCH CURVED DOCKING,

No-one can match Philips for its mix of quality, features and value, especially when it comes to curved MVA monitors such as this. It's great for casual gamers and busy workers alike, with USB-C docking and superb colours.

$849, philips.com.au

EIZO FLEXSCAN EV2480

Businesses in particular will love this easy-to-roll-out 24-inch monitor, with its exceptional five-year warranty, USB-C port for easy docking, excellent viewing angles and delicious whites. And it has the best OSD around.

$699, eizoglobal.com

DAHUA DHI-LM28-F420

This affordable 4K monitor might not offer much in the way of menu options or high-end gaming perks, but it offers impressive resolution and colour for ally pay.

$269, dahuaaustralia.com.au

PROFESSIONAL MONITORS

EIZO COLOREDGE CG319X

CREATIVE MASTERCLASS, $7,119

As the price indicates, this monitor is for heavyweight creatives who demand the best in every discipline: HDR video editing, print layouts, professional photography and more besides. With superb coverage and accuracy across all spaces, plus a built-in calibrator, it justifies the investment.

$7,119, eizoglobal.com

BENQ PD2725U

By no means a cheap 4K 27-inch monitor – unless you compare it to the Eizos – but it marries all-round quality with ease of use thanks to a puck that allows you to quickly move between settings. You can even daisy chain a second Thunderbolt 3 monitor for a monster setup.

$1,799, benq.com

EIZO COLOREDGE CG279X

Designers who need to work across different disciplines will love how easy it is to switch between the Adobe RGB, DCI-P3 and sRGB colour spaces using the Eizo's fantastic OSD. It's certainly not cheap for a 27-inch 1440p monitor, but it's packed with quality.

$3,095, eizoglobal.com

HOME OFFICE PRINTERS

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BACK TO BASICS

There's nothing flashy about this bottle- fed inkjet: it's there to churn out pages at a decent rate (8.8ppm for black text) for a low price. It comes with enough ink for 4,500 black pages and 7,500 in colour, but refills are cheap. Just don't expect features like duplex printing.

$299, epson.com.au

CANON PIXMA PRO-200

Yes, it's big and it's expensive – and you don't even get a scanner – but the Pixma Pro-200 means that you can print A3 photos with glorious colour accuracy and detail. If you're after an office workhorse, look elsewhere, but it can't be beaten on photo quality.

$809, canon.com

BROTHER MFC-J4540DWXL

Home workers will love this inkjet all-in-one. It combines an incredible range of features with all the connectivity you need and extreme ease of use. Output quality is fine, it offers the best cloud support around and the high-capacity ink pack could keep you going for years.

$420, brother.com

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Fast, well-featured and secure, the Synology RT6600ax is as perfect for professionals and prosumers as much as it is for SMBs and smart homes.
$599, synology.com/au

ASUS RT-AX82U
The impressive RT-AX82U punches well above its price when it comes to raw Wi-Fi 6 performance and includes a fistful of useful features – such as an ultrafast 20Gbits/sec USB connector, outbound VPN support, site-blocking and a host of parental controls.
$320, asus.com/au

HUAWEI WS7200
This affordable Wi-Fi 6 router delivers consistently fast wireless speeds, broad coverage and a modest speed boost for newer hardware – and the Router 3 has a cute design too. If you need more range, you can pick up a second unit to use as an extender.
$120, huawei.com

MESH WI-FI

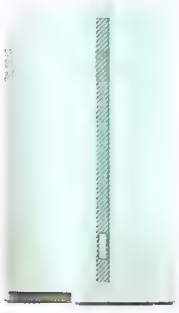
TP-LINK DECO XE75 AXE5400
SUPERB WI-FI 6 MESH
Offers the simplicity, speed and range most people want from a mesh system. While it's expensive, nothing else offers the plug-and-play simplicity, speed and range afforded by the Deco XE75.
$999, tp-ink.com

TP-LINK DECO X20
The price below isn't a typo: the Deco X20 makes it possible to upgrade your home network to Wi-Fi 6 – as well as manage its security – for the price of some standalone routers. The included HomeCare functions are also a great bonus for households where lots of devices are fighting over the bandwidth. **$199, tp-link.com**

ASUS ZENWIFI AX
The interface and design certainly aren't the prettiest (the nodes look like mini space heaters, while the charcoal version is straight out of the 1980s), but if you're after strong performance, great features and plenty of expansion potential, the ZenWiFi AX is a compelling prospect.
$949, asus.com/au

NAS SERVERS

QNAP TS-130
SIMPLE HOME NAS
An above average CPU and RAM combo, solid features and affordable price make the QNAP TS-130 worth considering. Alternatively there's the two bay TS230 which features the same CPU, with 2GB of RAM, dual drive bays, and an extra USB port on the front for a modest $50 price increase.
$250, qnap.com



ASUSTOR NIMBUSTOR AS5304T
This is a hugely powerful four-bay NAS that will be overkill for most people – not just due to its speed but also its slightly intimidating user interface – but techies and gamers should investigate the Nimbustor AS5304T for both its speed and flexibility.
$799, asustor.com

SYNOLOGY DISKSTATION DS1522+
At $1,199 it's not cheap but factoring in the software means it's great value. Though some internal silicon may lack headroom, this is still a well-featured, expandable NAS with fantastic software. The best part is the DSM software.
$1,199, synology.com

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1-3 PCs, 1yr, $99.99, f-secure.com

ALTERNATIVES

NORTON 360
Consistently on the podium in our group tests, and loaded with an abundance of genuinely useful features, including a VPN and generous cloud backup.
1 PC, 1yr, $79.99, nortonlifelockpartner.com

AVAST FREE ANTIVIRUS
For the second year running, Avast is our top pick for free antivirus software – it's simply lighter on its feet than Microsoft Windows Security, whilst offering fewer false positives.
Free, avast.com

VPNs

NORDVPN
NordVPN provides consistent and fast speeds, serious security, great support for video-streaming services and some cost-effective subscription rates.
$59 per year, nordvpn.com

ALTERNATIVES

PROTONVPN
ProtonVPN provided one of the best free offerings of all the VPNs in our group test, including unlimited data, but upgrade to benefit from even faster speeds and many more options.
Free, protonvpn.com

SURFSHARK
A strong rival to NordVPN, especially if you're willing to commit to its two-year contract. It's fast, cheap and a fine choice for people who like to switch to US streaming services.
$66.34 for one year, surfshark.com

PASSWORD MANAGERS

BITWARDEN
Bitwarden has a huge advantage: it's free. It isn't as slick as some paid-for rivals, but it can sync passwords across all devices for no extra charge. **Free, bitwarden.com**

ALTERNATIVES

DASHLANE
A manager that's ideal for beginners, and it even builds in an unlimited (if basic) VPN service. Note you may prefer to buy the Family plan ($60 per year) as this extends the service to six people.
$55.99 per year (Premium), dashlane.com

1PASSWORD
1Password is targeted at technically minded users who are looking for the last word in security. It even offers a Travel Mode that may ease your mind if surrendering your phone to customs officials.
$54.99 per year (individual), 1password.com

The top five PC game controllers

Mouse and keyboard is the godlike choice when it comes to playing games on PC, but even we have to concede, there are times when a good old game controller does it best. Thankfully, there are some excellent choices for PC gamers who want to play just like their console brethren. This can only be a good thing, especially given the number of PlayStation and Xbox titles being released in their definitive form on our platform of choice.

❶

XBOX ELITE WIRELESS CONTROLLER SERIES 2

The only downside to using Microsoft's reassuringly expensive game controller is that it makes all standard controllers feel cheap and nasty in comparison. It's luxurious to hold, has a host of customisation options, and multiple controllers can connect to one USB wireless dongle (not included). The controller also comes with a charging case and can be used wired or wirelessly.

$249, www.xbox.com

❷

SCUF INSTINCT PRO

This premium controller is the main competitor to Microsoft's official pad but offers a huge variety of cosmetic options. There are new faceplates and thumbsticks to choose from, the latter of which vary in terms of length and topper. You can also remove the rumble motors if you're an eSports player who doesn't need such distractions. **$345, www.scuf.com**

❸

RAZER WOLVERINE ULTIMATE

The Wolverine Ultimate is a great choice if you game across both Xbox and PC, but there is a catch – it can't connect to the PC wirelessly. The pad's USP is its clicky face buttons, which feel like mouse buttons for a satisfyingly tactile response. This being Razer, there's also Chroma RGB support, although it's done through a separate mobile app, not a native PC one.

$265, www.razer.com

❹

SONY DUALSENSE WIRELESS CONTROLLER

The PlayStation 5's native controller is the most advanced, technically speaking, thanks to its brilliant haptic motors and adaptive triggers. Sadly, the majority of PC games don't support these advanced features, but the tide is beginning to turn – Marvel's Spider-Man Remastered integrates with Sony's DualSense and we expect more PlayStation ports to follow.

$119, www.playstation.com

❺

POWERA SPECTRA INFINITY ENHANCED

PowerA's officially licensed Xbox controller is wired and covered with lighting, but its main draw is that it's a great controller at a brilliant price. It's just like Microsoft's own Xbox controller, except it also has two programmable buttons on the rear.

$79, www.powera.com

HEAD TO HEAD

Plex vs. Jellyfin

Do you need to pay for a media streaming server?

■ PLEX | $Free, Plex Pass costs $6.49 (month), $49.99 (year) or $159.99 (lifetime) | www.plex.tv
■ JELLYFIN 10.8 | $Free | https://jellyfin.org/

One media server to rule over them all. That's the dream of anyone hosting a huge collection of media they would like easy access to. For years, that media server has been provided by Plex, a beautifully designed, slick, and powerful tool. While its core functionality is free, there is also a paid-for subscription in which you can unlock extra goodness and features.

However, over the past few years, a young pretender has emerged. Forked from Plex-rival Emby's last open-source implementation, Jellyfin's key commitment is to remain free and open-source for 'now and always'. As we reach its fourth anniversary, now is the perfect time to see how Jellyfin measures up to Plex and which one offers the better overall experience.

When it comes to core functionality, there's little to choose between the two. Both Plex and Jellyfin employ the same server-client model, which delivers your media from a centralised PC, NAS, or server to your various devices on demand. Both apps run beautifully on low-powered hardware, making 24/7 access practical and affordable. Both support a wide range of clients – Plex has the edge, but Jellyfin is closing the gap fast, and also offers both Android and iOS apps for free; Plex users either require a Plex Pass subscription or must pay a standalone fee ($6.49) for each app.

A key area where Plex and Jellyfin diverge is in how users access the server. Plex requires you to set up a centralized account via Plex's website and connect through that. Configuring your server for remote access and sharing is easier, but there's the question of privacy – one brought into sharp focus by the recent hacking of Plex's servers. You're also forced to route your connection through Plex's online servers even when on the same local network – an 'offline' mode is available when the internet is down, but it's slow to appear.

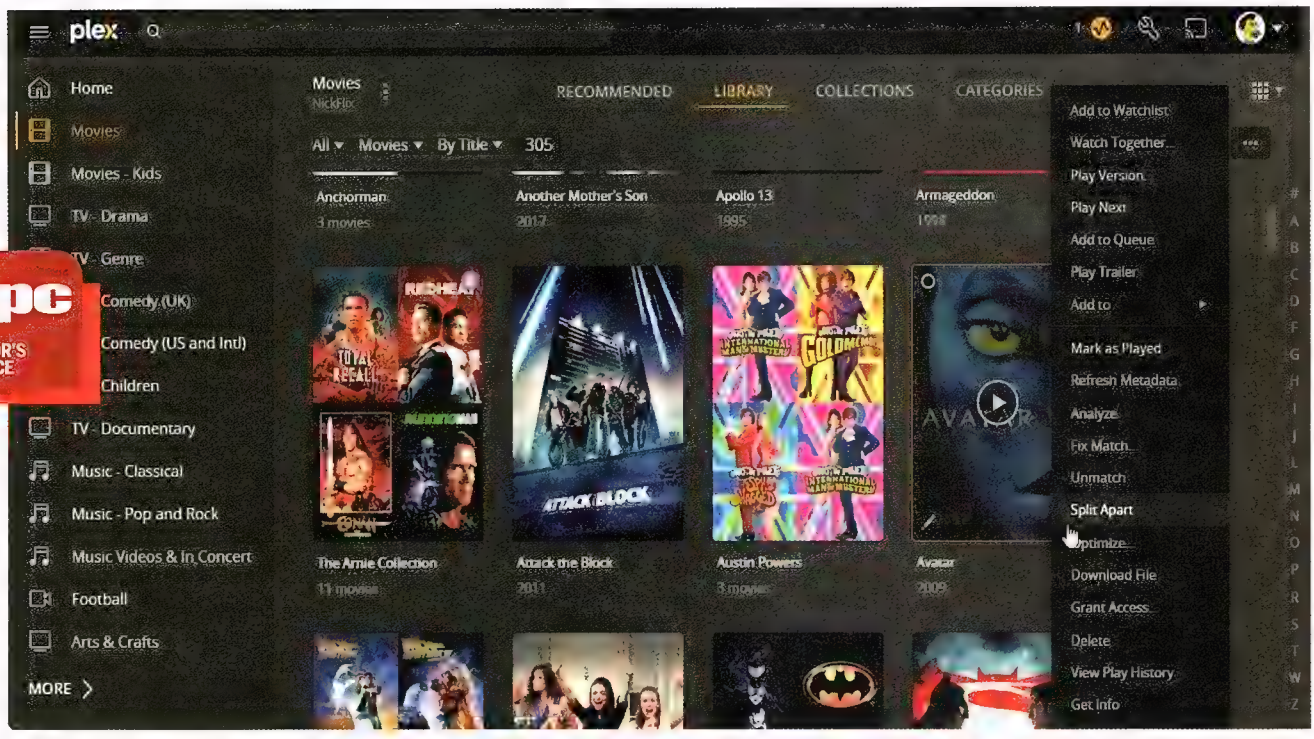
On the other hand, Jellyfin employs a direct connection to the server, which can be via your local network or over the internet if you have a domain name and reverse proxy. It's rather fiddly to set up, but once done, it works flawlessly. Long story short, if privacy is your thing, Jellyfin's model is the one to go for.

How you store, organise and access your media is a crucial part of any media server, and both apps do an excellent job. If your media is named and stored in the correct folder structure, then your library is populated with rich information providing detailed descriptions down to an episodic level for TV series, along with artwork and additional information about actors, ratings, and so on.

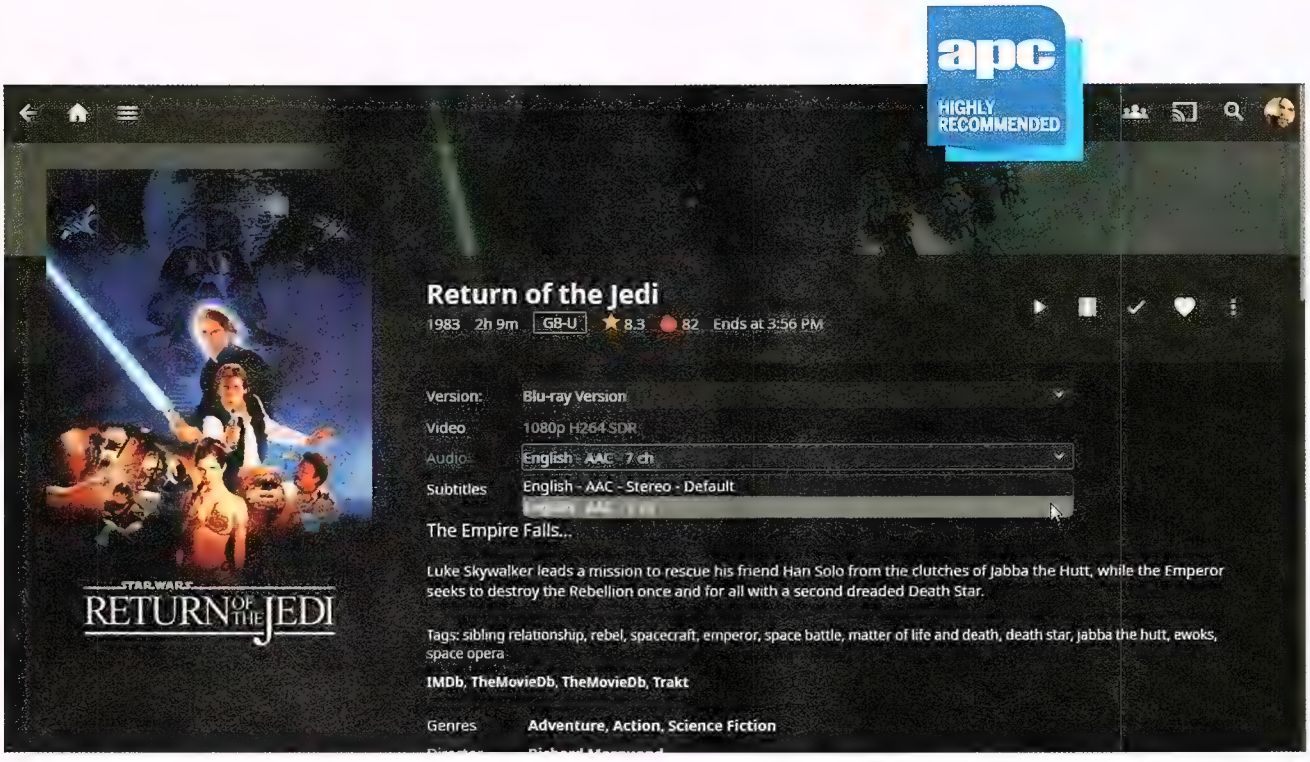
Above and beyond

Both apps do an excellent job of presenting this library in an attractive and easy-to-navigate view across their various clients. And they go above and beyond with support for incorporating extras, such as documentaries, deleted scenes, trailers, and so on, into your library too. Here, Plex currently has the edge, and not just with Plex Pass subscribers who will find a range of extras have been made available online to stream alongside any locally curated ones.

One example of the cut and thrust



Slick navigation and powerful features mean that Plex remains our winner – but only just.


apc
HIGHLY RECOMMENDED
Return of the Jedi
1983 2h 9m GB-U 8.3 82 Ends at 3:56 PM
Version: Blu-ray Version
Video 1080p H264 SDR
Audio English - AAC - 7 ch
Subtitles English - AAC - Stereo - Default
The Empire Falls...
Luke Skywalker leads a mission to rescue his friend Han Solo from the clutches of Jabba the Hutt, while the Emperor seeks to destroy the Rebellion once and for all with a second dreaded Death Star.
Tags: sibling relationship, rebel, spacecraft, emperor, space battle, matter of life and death, death star, jabba the hutt, ewoks, space opera
IMDb, TheMovieDb, TheMovieDb, Trakt
Genres Adventure, Action, Science Fiction
STAR WARS
RETURN OF THE JEDI
It's a close race, but Jellyfin stumbles slightly with its less friendly UI.

of development between the two can be found in their TV extras. Initially, users were compelled to house all specials, including featurettes and deleted scenes, within a single Specials folder. Jellyfin 10.8 raised the stakes by allowing specials to be embedded at the season level, while Plex went down the route of embedding extras at the episodic level (perfect for deleted scenes, for example). Plex has subsequently added season-level support, while Jellyfin's Github reveals that it is developing support for episode-based features on the Plex model.

This level of detail may seem like overkill, but for true media connoisseurs, they are essential improvements that highlight both apps' commitment to their core offerings. That's important, as the majority of Plex's development over the past few years appears to have been in widening its remit.

Bells and whistles

Beyond their core functionality, what else is on offer? Both services can be connected to a TV tuner and used to stream live TV (perfect when away from home) as well as function as a DVR, with recordings placed in your library. Plex users require a Plex Pass to access the DVR. Both Jellyfin and Plex also support hardware-accelerated streaming and transcoding, to reduce the load on your CPU. Sadly for Plex users, hardware transcoding is another option restricted to Plex Pass users.

These features sit comfortably with existing functionality, but it's here where the two apps start to diverge once again. Jellyfin continues for the most part to focus on its main remit, but through a range of plugin models, it has made it possible to add extras, for example, the Jellyfin Bookshelf Plugin adds support for audiobooks, eBooks, and digital comics.

> "Both apps do an excellent job of presenting this library in an attractive and easy-to-navigate view across their various clients."

Plex has found itself trying to find other ways to monetise the service, specifically by augmenting your existing content with others. It offers its own 'free' ad-supported streaming movie and TV channels to sit your existing content, while a recent collaboration with Tidal aims to encourage users to augment their existing music libraries with streaming content via another subscription.

When you strip away the extras, though, you're left with two apps that do pretty much the same thing, and they both do it well. At this point, the only way to really differentiate them is through their user interfaces, and it's here that Plex edges ahead. Take the implementation of subtitles, for example. Plex has built-in support for uploading and searching online for subtitles to integrate into your movies as you watch them– it's simple to access and works well.

In contrast, you will need to install a separate plugin (OpenSubtitles) in Jellyfin, link it to an account, and then configure your subtitles before watching the movie. Fiddly stuff is made even harder thanks to gaps in its documentation. That extra attention to user-friendliness and detail is why Plex wins by a nose in our head-to-head comparison.

Jellyfin is an excellent tool and more than holds its own with the free version of Plex, given it contains many features restricted to Plex Pass subscribers. It's also more configurable and scores highly with its direct server setup. But if you're happy to invest, then Plex's more polished look and wider device support give it the edge. For now, at least.

Plex Packed with features; easy to navigate and use.
Nick Peers
★★★★½

Jellyfin 10.8 Powerful and configurable; completely free.
Nick Peers
★★★★☆

TECHNOTES

Gadgets

Objects d'lush

❶ GOOGLE PIXEL WATCH

Google's finally got a smartwatch with serious health tracking chops.

$549 | store.google.com/au

We've been waiting to see what kind of wearable Google would be able to produce since the company acquired Fitbit at the start of 2021. The New Pixel Watch is by no means revolutionary, fronting a 1.2-inch AMOLED display that curves into a 41mm profile with a crown dial and side button to allow for easy navigation. Picking up all of Fitbit's health tracking functionality, there's no shortage of fitness smarts and this marries with a new expression of Google's longstanding Wear OS to offer the Google Assistant, Google Pay and a generous range of audio playback apps.

❷ LOGITECH G CLOUD

A handheld game streaming console.

US$300 | logitechg.com/en-us

Whether you want to use XBox Game Pass, Steam Link or Nvidia GeForce Now, Logitech's Cloud handheld gaming device allows you to play your favourite titles from anywhere. The unit comes with 2 x 2 MIMO Wi-Fi to give you a speedy connection and the slightly older Snapdragon 720G processor is more than enough to push low latency frames to the 7-inch FullHD display. The screen is better than what you get on the Steam Deck, but it's also lighter, higher resolution, brighter and offers 12 hours of gameplay.

❸ KINDLE SCRIBE

A little less reading and a little more writing.

From $549 | amazon.com.au

While there 's long been a range of Kindle devices, they've all stuck pretty close to the fundamental task of reading, but the latest Amazon e-reader wants to let you write notes too. The larger 10.4-inch display adds over 30 percent more screen to give you the space to scribble notes down over whatever you're reading or in their own Microsoft Word document. The Kindle Scribe comes with 16, 32 or 64GB of onboard memory and either a Basic Pen stylus or a Premium Pen that adds an eraser butt and a shortcut button to the standard stylus.

Vacation List
1. Renew passports
2. Buy new swimsuits
3. Confirm dog sitter
4. Hold mail delivery
5. Set up away mode for home
6. Get car rental
7. Reserve car to airport
8. Pull together list of restaurants
9. Download books for reading

❹ BOSE PORTABLE SMART SPEAKER

A new portable speaker that works just as well at home.

$549.95 | bose.com.au/en_au

Now that we're allowed back outside this summer it's probably not a bad time to upgrade your portable speaker, and why not do it with one that fits into your multi-room home speaker setup. The Bose Portable Smart Speaker comes with a charger base that allows it to act like a regular smart speaker while it's charging at home. With both Amazon Alexa and Google Assistant compatibility, and Wi-Fi streaming you can simply add this speaker to your multi-room home speaker setup and as long as you're in Wi-Fi range take it anywhere your music doesn't currently reach.

❺ RAVEN CNC

Take your custom PC build, prop creation or decoration game to the next level.

From US$2,729 | kck.st/3f1q6my

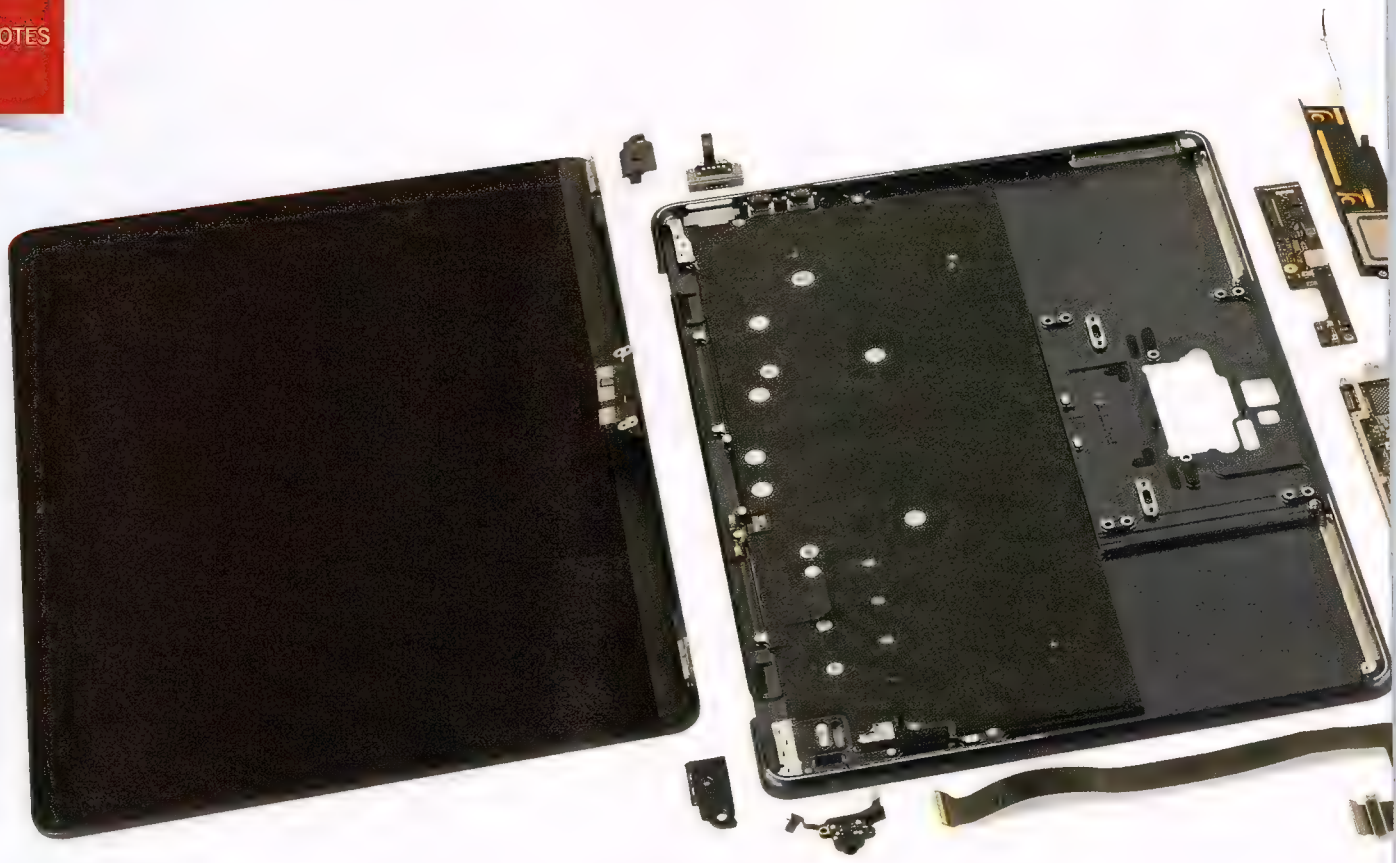
If you enjoy making your own tech as much as you do buying it, then it might be worth considering what you could do with a Computer Numerical Control (CNC) router (not the computer kind!) like the Raven CNC. This ambitious Kickstarter is aiming to be a complete package that'll provide both the software to design what you want to build and the device that cuts and turns the wood, foam or plastic into the precise object you've created want. If you don't have the 3D modelling skills to create what you want straight away there is a library of schematics that you can purchase to start making stuff straight away.

❻ LOGITECH MX MECHANICAL MINI FOR MAC

A mechanical ten-key-less keyboard for the Mac crowd.

$229.95 | logitech.com/en-au

Seeing as the Mac is having a bit of a resurgence these days, we suspect that at least a few of you will be interested in a dedicated keyboard for the other OS, and why not make it a mechanical one whale we're at it. The MX Mechanical Mini for Mac is kind of like a Magic Keyboard, except for the fact that it's got precise Tactile Quiet mechanical keys with decent travel distance. It's also capable of quickly cycling between up to three devices and will follow the Flow-enabled MX mouse across devices, along with any files you're trying to move.



HOW IT WORKS

MacBook Air with M2 chip

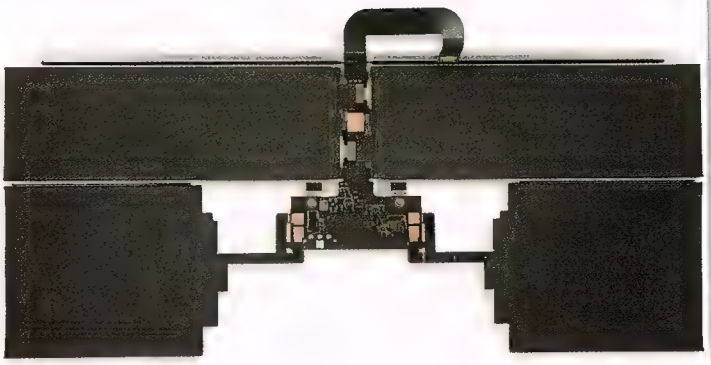
Apple's small but mighty ultraportable laptop deploys the latest silicon to impressive effect across creative work and even gaming.

Major tech specs

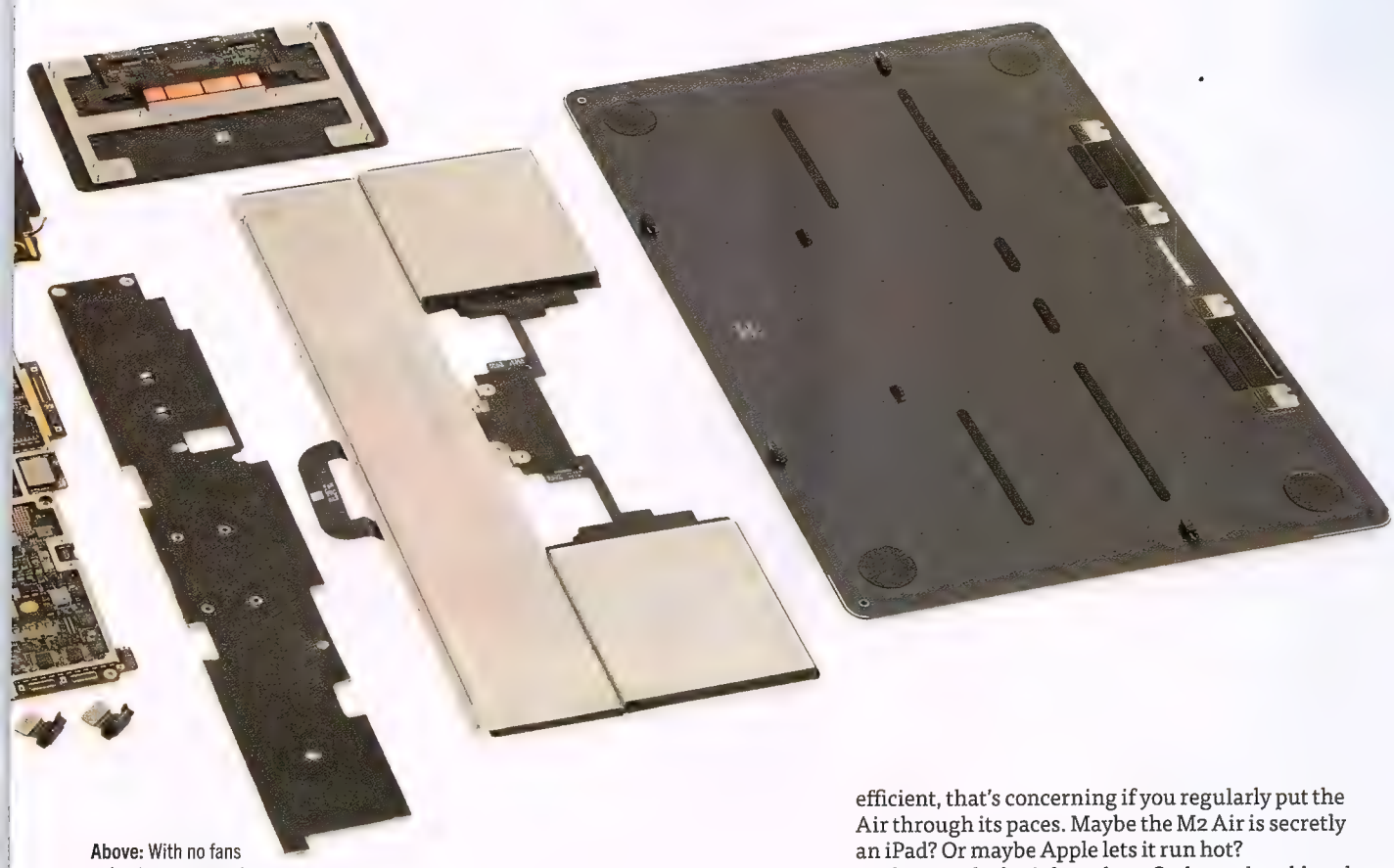
- Apple M2 chip 8-core CPU (four performance, four efficiency)
- 8-core or 10-core GPU
- 8GB RAM (configurable to 24GB)
- 13.6-inch IPS display with 2560x1664 native resolution
- 52.6-watt-hour lithium-polymer battery
- Ports: 2x Thunderbolt/USB 4, MagSafe 3 charging, 3.5mm jack
- 256GB SSD (configurable to 2TB)
- 802.11ax Wi-Fi 6 and Bluetooth 5.0
- 1080p Webcam
- Dimensions: 0.44 x 11.97 x 8.46in (1.13 x 30.41 x 21.5cm)
- Weight: 1.24kg

Key findings

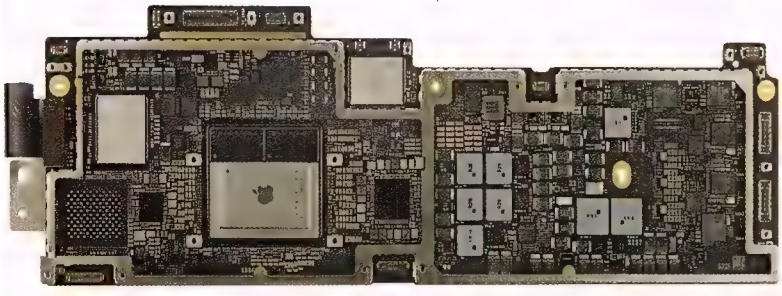
- The latest Macbook Air with M2 chip is thinner and lighter than its M1 predecessor, and also has a bigger display. There's an extra port in the form of the popular MagSafe connector. Speaker grilles replace the old perforated case design, with sound pumping out between the case and the display.
- You only need to remove four screws to get into the Macbook Air, but it requires some tugging to get the bottom panel away from the chassis. Remove the tiny screws and brackets and open a trap door to disconnect the battery from the logic board. It is now safe to start excavating the main part of the system. So far, not so difficult, compared with previous Macbook Airs.
- Now start removing items from the logic board, such as screws, brackets, and other fiddly items. Then take off the clip-on shield to remove the logic board. Here, you'll discover the Macbook Air's heat management, or should we say, lack of.
- Once the logic board is out, you're left with the metal shielding. There's no heat spreader, just a large gap, a lot of thermal paste, and some graphite tape. While the M2 is



Above: While the Air's battery has four cells, the top two are in parallel and the bottom two are in series, making it operate like a three-cell battery. Don't ask us why, though.



Above: With no fans or heat management system, Apple's MacBook Air may get a little warm.



Above: The compact main board looks similar to the one in the iPad, which it kind of is now Apple is using the same architecture with Apple Silicon chips.

Below: There are four screws to remove on this year's Air, rather than ten previously. Don't be afraid when pulling it off, it takes some force.

efficient, that's concerning if you regularly put the Air through its paces. Maybe the M2 Air is secretly an iPad? Or maybe Apple lets it run hot?

- Looking at the logic board, we find mostly soldered-down chips, affecting the upgradeability potential. These include the octa-core M2 plus unified memory package plus integrated GPU, a single 256GB NAND flash memory chip (with space for a second unit), and a USI chip that is likely just Wi-Fi and Bluetooth. There's an accelerometer, the same as in Apple's new Studio Display, and an Apple-made Thunderbolt 3 driver.
- Other accessible items include the trackpad, which is freed by loosening a few screws and washers. There are also four speakers that can be accessed via some screws, but also some hinge covers that are a nightmare to access. Other components, such as the USB-C port, headphone jack, and MagSafe connector are modular and not glued down, so should be easy to replace. The audio board is thin and easy to get out, as is the TouchID button, which comes out easily through the top case.
- The battery is attached to the case with stretch-release adhesive. The battery is in a U-shape design with four cells at a total rated capacity of 52.6Wh – enough for up to 15 hours.
of wireless web use thanks to Apple's optimizations.
- Repairability score: 4 out of 10 (10 is easiest to repair). It's easier to open up this year's Air, thanks to fewer screws, but everything is tucked away neatly, so it isn't easy to access the important components inside. You can't replace or upgrade the SSD or Wi-Fi chip, but you could replace the battery, trackpad, speakers, and keyboard. Apple has promised to release spare parts for this Air in the future, which counts as progress. ■

ABOUT IFIXIT

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products. To learn more, visit **www.ifixit.com**

ULTRABOOK

MSI Prestige 14 Evo A12M

MSI's premium Ultrabook offers powerful parts with a paired back price tag.

■ From $1,499 | au.msi.com

We've been fond of MSI's range of Prestige Ultrabooks for a couple of years now, and the team hasn't tweaked the recipe too much again this year. The Prestige Evo A12M comes in the same 31.9 by 21.9 cm sandblasted aluminium case, weighing in at 1.29kg with a thickness of 1.6cm. All this means the Prestige 14 Evo A12M is still competitive in terms of portability.

The major novelty this year is the updated Intel 12th Gen processors. You can get the Prestige14 Evo A12M with either an Intel Core i5-1240P or an i7-1280P CPU. The former comes with 16GB of RAM and a 512GB PCIe SSD that can be found online for $1,499, but the i7 model comes in various configurations from different vendors locally. These range up to models with 16GB of RAM and a 1TB SSD for $2,199.

This CPU is a big generational improvement that offers a new chip design with four performance cores and eight efficiency cores. That means you'll see anywhere from 12 to 320 percent performance bumps in processor heavy tasks over the last generation. The Prestige 14 Evo A12M again relies on the integrated Intel Iris Xe Graphics, but we saw 30 to 60 percent graphical performance bumps over last year's Prestige 14 A11M, especially in less demanding 1080p gaming.

	MSI Prestige 14	Evo A11M
PCMark 10 - Overall (score)	5,073	4,528
Max CPU Temperature (C)	96	99
Geekbench 5 - Multi-core (score)	8,721	4,617
Cinebench R23 - CPU ((multi-threaded))	11,441	3,482
3DMark Time Spy (score)	2,118	1,535
CrystalDiskMark Read (MB/s)	6,561	4,910
CrystalDiskMark Write (MB/s)	4,766	2,508

■ Windows 11 Home; 14-inch IPS display at 1920 x 1080 pixel resolution, 300 nit ; Intel Core i7-1280P CPU; Intel Iris Xe GPU; 16GB RAM; 1TB Gen 4 PCIe SSD; 53Wh battery (3h59min 1080p movie playback); 31.9 x 21.9 x 1.6cm; 1.29kg.

> "You'll see anywhere from 12 to 320 percent performance bumps in heavy tasks"

Up against something like the Dell XPS 13 or the 13 Plus this isn't a bad deal, seeing as you're getting one of 2022's top tier Ultrabook CPUs for less. That said, you do have to be happy to settle for the 1920 by 1080 pixel display with a peak brightness of 300nit. At full brightness it's fine for work and media playback for a 14-inch screen, but there are much more vibrant and detailed options if your budget can stretch a little. It's also worth pointing out that the 16:9 format has largely been abandoned by the leading

Ultrabooks for proportions that offer a bit more vertical space for better document editing and web browsing, which makes the ultra wide 14-inch display on the Prestige 14 Evo A12M seem a little dated.

MSI hasn't scrimped on the SSD offering leading read and write speeds of 6,561 and 4,766MB/s respectively. It's also got a keyboard that's nice to type on for extended periods and a wide, smooth trackpad.

Thanks to the new Intel processor the 53Wh battery is an improvement over last year's Prestige 14, with the update offering eight hours and 23 minutes of light work. This will get closer to taking you through a full work day, but it's still not quite there yet. That battery life diminishes to around four hours for 1080p movie playback, so the Prestige 14 Evo A12M isn't a device that'll let you leave the charger at home.

apc HIGHLY RECOMMENDED

A decent premium Ultrabook for those that don't need a fancy screen.

Joel Burgess

★★★★☆

ULTRABOOK

Dell XPS 15 (9520)

Can the XPS 15 outplay the MacBook Pro 16 with a new CPU, better battery and a hefty discount?

■ $2,924 | dell.com/en-au

TWhile the Dell XPS 15 misses out on the developments you'll see on the XPS Plus 13 (*APC 510*), by using the existing XPS chassis Dell is able to pack in even more premium components while keeping the price down. This is by no means a compromise either since the cool carbon fibre clad chassis is sleek and functional, offering both a sturdy structure and an insulated keyboard surround.

One of the biggest perks is a 14-core i7-12700H CPU which outpaces Apple's M1 Max processors in some benchmarks. This CPU is backed by a Nvidia GeForce RTX 3050 Ti GPU, 16GB of RAM, a 512GB SSD and a 1080p screen on the entry level configuration. The RRP for this unit is $3,499, but interestingly we've seen solid discounts on equivalent models with a 3.5K OLED touch or 4K 500nit touchscreen displays that bring them down to around $3,000 direct from Dell, so it's worth keeping an eye out for a discount.

While the M1 Pro has a lower wattage than the i7-12700H, the XPS 15 seems to be benefiting from Nvidia's new Optimus GPU switching tech since its battery life has jumped from around six hours of 1080p movie playback on the last generation to over 10 hours on the new generation. And while this is a way off the MacBook Air M2's 19 plus hours, it actually manages to outlast the MacBook Pro 16 with a M1 Max processor.

While the i7 CPU is already one of the most powerful available, you can up it to an i9 for an additional $400. Both will be able to handle any workload you'll throw at it and when paired with the 40W 3050 Ti you'll get playable 30fps plus framerates on modern titles with 1080p Ultra settings. With 32GB or 64GB of RAM this configuration will be one of the most powerful Ultrabooks you can get this year and if you can nab one on a 25 percent discount, it's hard to see anything else coming close to offering value as good.

■ Windows 11 Home; 15.6-inch 500nit touchscreen display at 3840 x 2400; Intel Core i7-12700H CPU; Nvidia GeForce RTX 3050 Ti (40W) GPU; 16GB DDR5; 512GB PCIe SSD; 86Wh battery (10h7min 1080p playback lifespan); 34.4x23x1.9cm; 1.92kg.

The two higher resolution screens are some of the best available offering either a 3.5K OLED at 400 nits or an UltraHD display at a brighter 500 nit peak brightness. Dell doesn't advertise the colour specifications of these displays, but you can apparently opt for Adobe RGB calibration, so you've got the option for professional colour grading capabilities if you need it. The 15-inch screen is also a great balance of portability and screen workspace for creatives that work on the fly a lot.

Dell has also updated the storage on this unit to offer PCIe Gen 4 SSD speeds. This means you'll see peaks of 6,887MB/s read and 4,431MB/s write speeds under general usage conditions. This effectively doubles the storage speed from the last generation and brings it up to be functionally equivalent to Apple's MacBook Pro 16. So there's really not much more you could ask for from the XPS 15 (9520), especially if you can get one on sale.

	Dell XPS 15 (9520)	Dell XPS 15 (9510)
PCMark 10 - Overall (score)	6,811	6,238
Geekbench 5 - Multi-core (score)	11,379	7,557
Cinebench R23 - CPU (multi-threaded)	13,500	8,505
3DMark - Time Spy (score)	4,641	4,637
1080p movie playback (HH:MM)	10:07	6:03
Peak CPU temperature (°C)	100	100
CrystalDiskMark Read (MB/s)	6,887	3,214
CrystalDiskMark Write (MB/s)	4,428	2,868

Top performance and specs for creative pros at an unbeatable price.

Joel Burgess

★★★★★

ULTRABOOK

LG Gram 2-in-1 16”

The Gram range has a new convertible Ultrabook to catch creatives.

■ $3,399 | lg.com/au

It's refreshing to have a new player in a tech space, since they will often bring new ideas that push different areas forward. LG's Gram devices have been doing this in the Ultrabook space, but this year it's also branching out into the convertible arena with the LG Gram 2-in-1 16”. Most vendors other than Microsoft and Lenovo have been pulling back from the saturated 2-in-1 space over the last few years, but considering the laptops LG has made thus far, it's not totally out of the ballpark for it to have a crack.

The LG Gram 2-in-1 16” is a convertible that builds on a decade of competitors' designs using a large 16-inch screen in a high resolution 16:10 aspect ratio with a pair of fixed 180-degree folding hinges. Lenovo have leaned into the main benefit of a 2-in-1 by including a stylus and collaborating with existing sketching/ notes software from Wacom and Bamboo that work well out of the box. Unfortunately, next to something like the Surface Laptop Studio the sketching experience feels like an imperfect workaround and the years and years of refinement by Lenovo's Yoga range make them impossibly good value with comparable units going on sale for $2,199, rather than the $3,419.95 RRP of the LG Gram 2-in-1 16”.

The one area where LG Gram 2-in-1 16” does genuinely compete is in the device's weight. It's not quite as light as the Surface Pro 8 with a Surface Pro Signature Keyboard which comes in at 1,185g when combined, compared to the Gram 2-in-1 16's weight of 1,480g. The Surface Pro, however, only has a 13-inch screen, so the Gram 2-in-1 16's weight is actually pretty impressive, especially when you consider the Yoga 7i 16” weighs close to 2kg.

There's a couple of unnecessary mistakes like the stylus not having any magnetic storage on the laptop, and the unit missing out on a fingerprint reader, but the keyboard and trackpad are nice to use and there's a decent selection of ports. LG has also developed some web conferencing software that automatically blurs the background, cuts out background noise and can automatically mute and unmute you depending on how far you are from the screen.

Performance was generally where you'd expect from i7-1260P on general work tasks, but this could drop to around 10 to 18 percent behind a Dell XPS 13 and an Acer Swift 5 we tested with the same processor. While all these devices hit the 100-degree thermal threshold, clearly the lightweight LG Gram 2-in-1 16” is hitting this earlier, so if you do a lot of photo editing or heavy creative work then you should expect a bit of a performance cut.

Unfortunately it's the same scenario with the GPU landing 12-17 percent behind other devices with the same setup. This underperformance means it can't really play modern games on low settings like some can.

Considering you'll get around a full day's work out of the battery (and over 13 hours of movie playback), there's no fatal flaws here, but it's not quite the game changing 2-in-1 device that'll draw you away from a Surface or Yoga unless you need a 16” screen that is as light as possible and you don't mind taking a performance and pocket hit in order to get it.

■ Windows 11 Home; 16” IPS LCD display at 2560x1600 pixel resolution, 99% DCI-P3 colour; Intel Core i7-1260P CPU; 16GB RAM; Intel Iris Xe Graphics; 80Wh Battery (13h 22min 1080p movie playback); 35.6 x 24.8 x 1.7cm; 1.48kg.

	LG Gram 2-in-1 16	Dell XPS 13 Plus
PCMark 10 - Overall (score)	5,125	5,125
Max CPU Temperature (C)	100	100
1080p movie playback (HH:MM)	13h22min	6h6min
Cinebench R23 - CPU (Score)	6,820	8,161
3DMark Time Spy (score)	1,631	1,953
Geekbench 5 - Multi-core (score	7,792	8,594
CrystalDiskMark Read (MB/s)	6,951	7,082
CrystalDiskMark Write (MB/s)	7,082	5,095

A decent 16-inch convertible that's a bit expensive, a little slow and kind of late to the 2-in-1 party.

Joel Burgess

★★★★☆

ULTRABOOK

Asus ZenBook 14X OLED

Is there space at the top for Asus's new Space Edition Zenbook 14X OLED?

■ $2,499 | asus.com/au

It's difficult to stand out in the extremely competitive premium Ultrabook space these days, which is perhaps what's driven Asus to design the Zenbook 14X OLED Space Edition. This new release has a somewhat inspired design with a few cosmetic nods to various nerdy space concepts and a mini 3.5-inch OLED ZenVision display that sits on the outside of the case. This mini-screen can give you info like time and battery life, but it's mainly there to cycle through animations that make the laptop look like a HAL 9000 interface.

This novelty screen is definitely outshined by the main 14-inch OLED display, which offers some serious colour specs, a 2880 by 1800 pixel resolution, and a 550nit peak brightness. Vesa has certified it with HDR 500 True Black, which is a slightly different label reserved for OLED displays because of the large improvement in contrast you get over standard LED. It also meets full DCI-P3 colour which makes it an excellent screen for any image and video professionals that can work on a compact 14-inch screen.

Asus has chosen to fit this device out with an Intel i7-12700H CPU which draws 35W of power over the 28W i7-1280P. This gives it between four

■ Windows 11Home; 14-inch 90Hz OLED display at 2880 by 1800 pixel resolution; Intel Core i7-12700H CPU; 16GB RAM; Intel Iris Xe Graphics GPU; 512GB PCIe SSD; 61W battery (5h30min 1080p movie playback); 31.1x22.1x1.6cm; 1.4kg.

and 16 percent better performance while drawing up to 25 percent more power, an equation that's a bit disappointing when you consider that the work lifespan is six hours and 49 minutes and the 1080p movie playback is just five and a half hours. It also might be part of the reason why it's 110g heavier than something like the MSI Prestige 14 Evo A12M.

If you can live with a lower battery life then this is by no means a bad unit. 16GB of RAM and a fast Gen 4 SSD mena it's more than powerful enough for any work task you throw at it and the 7,000/5,000 MB/s read and write storage speeds give it an edge over some of the other top Ultrabooks of 2022. Despite offering a bigger CPU the i7-12700H uses the same Intel Iris Xe Graphics, so don't expect anything more than standard integrated graphics. This isn't abnormal for a 13 or 14-inch Ultrabook, but it doesn't make the most of the 90Hz refresh rate on the OLED display. You will still get playable frame rates on lighter games on low 1080p graphics settings, but it's up to 38 percent behind what you'll get from a MacBook Air (M2).

The Zenbook 14X OLED is a really nice device to type on and the oversized trackpad is more than fit for purpose, transforming into a digital number pad when needed. It's only got a 720p webcam, but if you're a fan of traditional interface options then this unit comes with a USB Type-A, an HDMI port and an SD Card reader, in addition to the usual Thunderbolt ports and a 3.5mm headphone jack.

Asus' WiFi Master tech means you'll get Wi-Fi speeds as good as today's best laptops, which can be anywhere up to three times faster than what you'll get on devices that are a couple of years old.

	Asus Zenbook 14X OLED Space Edition	MSI Prestige 14 Evo A12M
PCMark 10 - Overall (score)	5,571	5,073
Max CPU Temperature (C)	97	96
PC Mark 10 Battery Work (h:min)	6h49min	8h23min
Cinebench R23 - CPU (Score)	11,947	11,441
3DMark Time Spy (score)	2,068	2,118
Geekbench 5 - Multi-core (score)	10,127	8,721
CrystalDiskMark Read (MB/s)	6,700	6,561
CrystalDiskMark Write (MB/s)	4,908	4,766

A decent premium Ultrabook with solid screen specs and a disappointing battery life.

Joel Burgess

★★★★☆

MONITOR

Samsung 55" Odyssey Ark

This screen is the most immersive monitor money can buy, but it comes with some major caveats that will be an Achilles' heel for some.

■ $4,499 | samsung.com/au

apc HIGHLY RECOMMENDED

■ 55-inch miniLED display at 3,840 x 2,160 pixel resolution; 165Hz refresh rate, <1ms response rate; AMD Freesync Premium Pro; 600cd/m2 Typ. Brightness (1000 nit peak); 1000R Curve; 95% DCI-P3 colour; Tizen OS; 2.2.2 Dolby Atmos speakers; 117.5x110.2x37.9cm; 41.5kg (21.1kg without stand).

Samsung has had great success with its ever growing range of ultrawide curved gaming monitors, so it's perhaps not surprising that the company has decided to take a risk on a TV sized curved gaming monitor in a 16 by 9 format. This screen is basically a 55-inch curved TV that comes with a solid screen mount to allow you to raise, lower, tilt and even rotate a full 90-degrees for a vertically oriented cockpit mode. This isn't abnormal for a monitor, but it's pretty unusual for a 41.5kg, 55-inch, desktop display.

So other than being enormous, the Odyssey Ark 4K has some pretty impressive technology in it. Starting with a 3840 by 2160 pixel resolution, the 55" Odyssey Ark also has an extremely low latency sub 1ms response time and can run at up to 165Hz. You'll need an impressive PC in order to push the display anywhere near its top framerate while in 4K, but this speedy refresh rate does give you the option to drop the resolution for those times you want ultra-high refresh rates.

When using an Nvidia RTX 3080 GPU we were able to get *Destiny 2* in 4K HDR to run at up to 80fps with G-sync keeping everything in check. If you have an AMD graphics setup then you'll be pleased to know that the device is Freesync Premium Pro certified, which means you can run compatible games in HDR at framerates well over 100fps. The only compatible game we tested with this premium HDR gaming tech was *Far Cry 5: New Dawn*, which limited you to a maximum of 60fps when running in 4K with Freesync 2 (HDR) colour or 120fps if you used 2.7K, Freesync 2 settings. So, if you're looking to run games in the top colour settings, be prepared for heaps of hoop jumping.

All these technical capabilities combine with a 600nit typical brightness to create a bright and vibrant display that looks stunning when you fire up a game in full screen. We were initially a little apprehensive about a 68cm tall screen on your desktop, especially given the unfavourable reception of curved televisions a few years ago. For media and games however, this format is exceptionally immersive, perhaps even more so than the Odyssey Neo G95A, which is something we thought couldn't be improved on.

Too good to be true?

While the screen is unparalleled on this front, there are unfortunately some major caveats that are really important to highlight. The first is that while it is pitched as a multitasker's dream setup, you can only have one physical input source displayed at a time. So for those hoping to plug their PS5 or XBox, a 4K Blu-ray player, and multiple computers in, and to have them all running at once you're gonna be bitterly disappointed.

Samsung has provided picture-in-picture capabilities to allow you to multitask, but only if you plan to have one of the other sources as: Samsung TV Plus (a free, ad-supported, digital TV service with 75 channels), a not-included webcam, Samsung Internet (the Tizen OS-based TV

internet browser), or YouTube. And while there could be a use case for these, even just in the advertising of this feature, often the second or third screen is just an animated wallpaper rather than something genuinely useful.

The other major limitation is that the 55" Odyssey Ark doesn't have an OLED panel. We were blown away by the colour and vibrancy of the Samsung-made panel on the Alienware 34 Curved QD-OLED Gaming Monitor, but the company decided to go a different direction here. The 55" Odyssey Ark screen is by no means bad. In fact the MiniLED backlight array on the 55" Odyssey Ark gives it significantly more darkness levels than standard LED backlighting arrays, but it's still a long way from OLED. When you're paying $4.5K for a screen, it's a really tough pill to swallow to consider you're not getting the absolute best picture quality around and if you've ever experienced a QD-OLED monitor it's not something you'll easily forget.

> "For media and games however, this format is exceptionally immersive."

The first Smart Monitor?

So while the multi-tasking chops need a bit of improvement, what actually works really well straight out of the box is the smart TV capabilities. We haven't seen these features on a large format gaming display yet, but it is the perfect addition to a screen that is designed to work as a TV as well as a monitor.

The inbuilt processor runs full Tizen TV OS, allowing you to easily swap to a couch experience using the dedicated TV-style remote. This is the same as what you'll see on any of Samsung's current Smart TVs and includes all of the major streaming apps you could want.

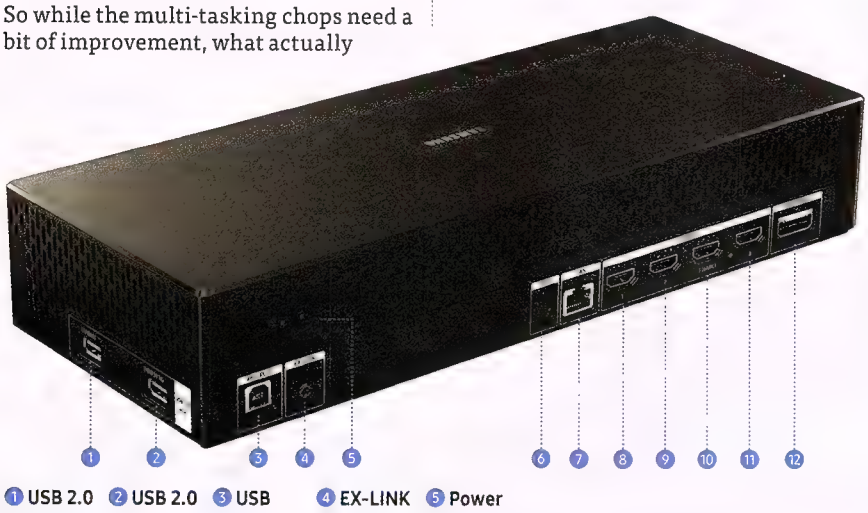
Samsung spent significant resources on ensuring this monitor has the same AI-powered Neural Quantum Processor Ultra chips as their flagship TVs. This investment helps translate various sources of media into the complicated 14-bit Mini-LED backlighting format required to produce such a detailed image. In addition to upscaling media into higher resolutions, this processor power can also improve colour reproduction from non-HDR or compressed HDR sources.

It's worth pointing out that this kind of automated enhancement doesn't always work, and we experienced occasional unwanted colour banding while running *Formula 1: Drive to Survive* on Netflix in 4K HDR. It also actually enhanced the pixelation of *Far Cry 5: New Dawn* when playing in a 120fps plus 1080p setting, so the tech is far from perfect. But for the most part it does a good job of improving the appearance of media in the background and even when it gets it wrong, it's usually fixed with a few tweaks of the settings.

Samsung also applied the anti-glare matte finish from its The Frame TVs on the 55" Odyssey Ark, but interestingly there's still enough screen glare to notice if you're using it in a reasonably bright room in the middle of the day.

In addition to the TV remote that comes with the 55" Odyssey Ark, there's also a tabletop Ark Dial that uses a large notched scroll wheel and a few buttons to make adjusting gaming and picture settings easier to navigate. The controls are a nice luxury that's sensible given that you're unlikely to be close enough to the screen to interact with controls directly on the monitor.

Fortunately HDMI 2.1 has the capacity to genuinely compete with DisplayPort 2.0 these days, since there's no way to connect the 55" Odyssey Ark to a computer via DisplayPort. The screen comes with a One Connect box with Multiple HDMI 2.1 inputs that are passed along the one cable with power to the screen to reduce clutter. This is a sensible solution for something attempting to look presentable in a living room, but it does mean you're limited to a 120Hz refresh rate when running 4K without colour compression.



1 USB 2.0 2 USB 2.0 3 USB 4 EX-LINK 5 Power
6 Optical 7 LAN 8 HDMI 1 9 HDMI 2 10 HDMI 3 11 HDMI 4 12 One Connect

An unbelievably immersive 55-inch gaming monitor that has a few niggly caveats.

Joel Burgess

★★★★☆

SSD

Western Digital Black SN850X 2TB M.2 NVMe SSD

Pushing the limits of PCIe 4.0.

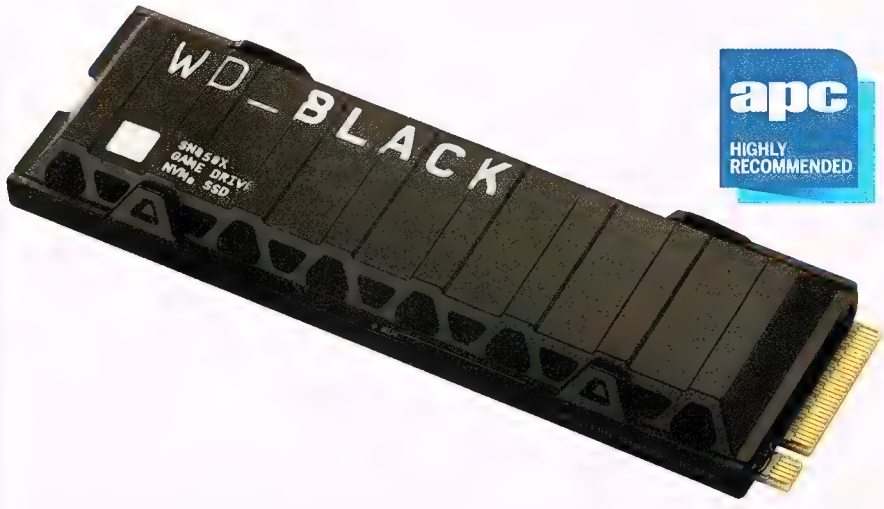
■ $509 | westerndigital.com

Despite the hype around upcoming PCIe 5.0 SSDs, good quality PCIe 4.0 drives aren't going anywhere anytime soon. Much like a quality PCIe 3.0 drive is relevant today, so too will a PCIe 4.0 drive remain. Although it feels a little bit late to market, even before testing it, the Western Digital SN850X is sure to remain a top performing drive for years to come, particularly with regards to its PS5 compatibility.

We have the 2TB SN850X with its optional heatsink in for review. It even comes with a splash of RGB lighting. It's available in 1TB and 2TB capacities, and unlike the non-X SN850, there's a 4TB option. This version costs a steep $509 at the time of writing, which is at least $50 to $100 more than top class Phison equipped drives. With that kind of premium, the SN850X needs to be a top performer.

The WD SN850X 2TB is a single sided standard form factor 2280 (80mm length) NVMe M.2 drive. It makes use of 112-layer BiCS5 TLC NAND, which on its face is a step behind the latest 176-layer Micron NAND that comes with the best Phison drives. The controller appears to be an upgraded version of the one that comes with the SN850. But having seen what WD is capable of with its firmware (notably the excellent SN770 that we awarded a full 5/5 score), we have high hopes for the SN850X.

Official specs include 7,300MB/s and 6,600MB/s read and write speeds with up to 1,200K and 1,100K read and write IOPS. The 2TB version comes with a 1,200TBW endurance rating and it comes with a 5-year warranty. The heatsink equipped models feature PlayStation 5 compatibility.



apc HIGHLY RECOMMENDED

■ WD Black SN850X 2TB M.2 NVMe SSD; PCIe 4.0 x4; BiCS5 112L TLC NAND; 7300 MB/s sustained read, 6600 MB/s sustained write,1200K/1100K read/write IOPS; 1200 TBW endurance; Five year warranty.

The SN850X is supported by WD's excellent Dashboard software which includes a new Game Mode function. It disables the low power states, and along with some other firmware tweaks, is designed to provide a consistent gaming performance. As DirectStorage supporting games emerge, this is a nice forward-looking feature.

Performance wise, the SN850X is an improvement over the SN850. Though it struggles to match the best Phison 176L drives in synthetic testing, it is the fastest drive we have tested in real world tests to date, including internal file transfers and 3DMark's new gaming storage test – the latter by over 10 percent. The differences are unlikely to be apparent in day to day use, but still, the SN850X's real world wins trump synthetic ones.

The SN850X with the heatsink got a bit hot for our liking, being hot to the touch and peaking at 75C. Under sustained heavy loads, throttling is possible, particularly without adequate airflow. Newer motherboards feature much larger heatsinks, and if yours is one of them, you should opt for the heatsink-less version.

Rating the WD SN850X presents a bit of a conundrum. It's right up there with the fastest drives we've tested, but its problem is its price. At $509, it's difficult to recommend over competing drives. Pricing is fluid though, and when WD's pricing stabilises in the market it will go from being a very good drive, to an outstanding one. If you're a gamer, it's definitely one to keep your eye on.

			WD SN850X 2TB	Seagate Firecuda 530 2TB
Crystal Disk Mark	Sequential Read MB/s		7377	6,688
	Sequential Write MB/s		7,387	6,876
Anvil Storage Utilities	4K Random Read MB/s	Queue Depth 1	81.70	80.40
		Queue Depth 4	301.20	316.20
	4K Random Write MB/s	Queue Depth 1	260.2	268.3
		Queue Depth 4	912.6	925.7
	4K Random Read IOPS	Queue Depth 1	20,916	20,320
		Queue Depth 4	76,598	80,957
	4K Random Read IOPS	Queue Depth 1	66,544	64,723
		Queue Depth 4	232,046	236,984
Internal File Copy	30GB of mixed file sizes		26	28
3DMark Storage Benchmark			3,982	3,531

The SN850X offers class leading real world performance, but its price premium counts against it in the face of strong competition..

Chris Szewczyk

★★★★☆

LAPTOP ACCESSORIES

TWELVE SOUTH CURVE FLEX

A good-looking, sturdy, but slightly flawed MacBook stand.

■ $139.95 | twelvesouth.com.au

Working from home over the past couple of years has made most of us realise how important ergonomics are. Laptop users have found the need to elevate their machines, and Twelve South has capitalised on that to improve on its laptop stand for MacBooks.

The Curve Flex has two adjustable tension hinges, which means you can not only adjust the height of your MacBook (or really any laptop that matches its base size) but also the angle at which it's placed. And this is why we really like Twelve South – those hinges are well made and set to the right tension already, but you can adjust them to your liking with the Allen key provided in the carry case that ships with the stand (an accessory for an accessory, yes!).

The flexibility the (ahem) Flex provides is great – your screen can be up to 22 inches above the desk and your keyboard can be angled at up to 45º. Placing a MacBook at an angle on the Curve Flex, however, can cause a few heart flutters. The hooks to hold the device barely touch the MacBook's edge when placed at an angle and the laptop has the potential to slide off.

That said, Twelve South has done well to provide some seriously impressive grip just where it counts. Textured silicone pads under the stand, on the top and on the hooks prevent any sudden falls but, buyer beware, most MacBooks aren't going to lock in place when kept at an angle.

As much as we love the elegance and remarkable build quality of the stand, Twelve South would have done better to have slightly longer hooks, particularly on an expensive accessory.

If the protective hooks were just millimetres taller, we'd have loved the Curve Flex even more, despite its high price.

Sharmishta Sarkar

★★★½☆

HEADPHONES

EPOS ADAPT 660 AMC

Stunning for work, average for play.

■ $855 | eposaudio.com

Epos has brought its specialist voice comms expertise to a standard Sennheiser set of cans, creating what is probably the best premium UC (unified communications) headset you can buy. The Sennheiser PCX-550 II they're based on is an older model, but offers reasonably good audio quality that is indeed acceptable for music and movies – though the balance veers heavily towards treble, which is fantastic for voice, but makes some music tiring and thin to listen to.

> "Sennheiser's already superb ANC is turbocharged with Epos' own UC firmware."

Sennheiser's already superb ANC is turbocharged with Epos' own UC firmware, and that includes a spectacularly good AI that learns and adapts to your surroundings and your voice, and benefits from having four mics built in. In a bustling office environment these shine. Getting up and running with any UC client like Microsoft Teams is a seamless experience, as intended by the design.

I can't rate the comfort highly. While light at 227g, I found them quickly feeling hot and heavy, and like my ears were being compressed. Others love them, so try before you buy, if possible. On the plus side, controls are minimal and well placed, and power on and off is done by twisting the cans into a flat-packing configuration.

Value is poor. The base Senny's can be had for under $400, so $855 is a bit rich for the UC features. Aston Martin F1 branding surely doesn't help, either.

These shine as the cans you want when travelling for work. Tight UC integration and the impressive ANC and adaptive AI make them just the thing when you're heading off for a few days of work and play.

Peerless UC capabilities, but for music quality your $800 will buy much more elsewhere.

Ben Mansill

★★★★☆

Windows 7, 8.1, 10 or 11, or macOS | Free | fing.com/products/fing-desktop

FING DESKTOP 3.0.0

The easy way to get your network right.

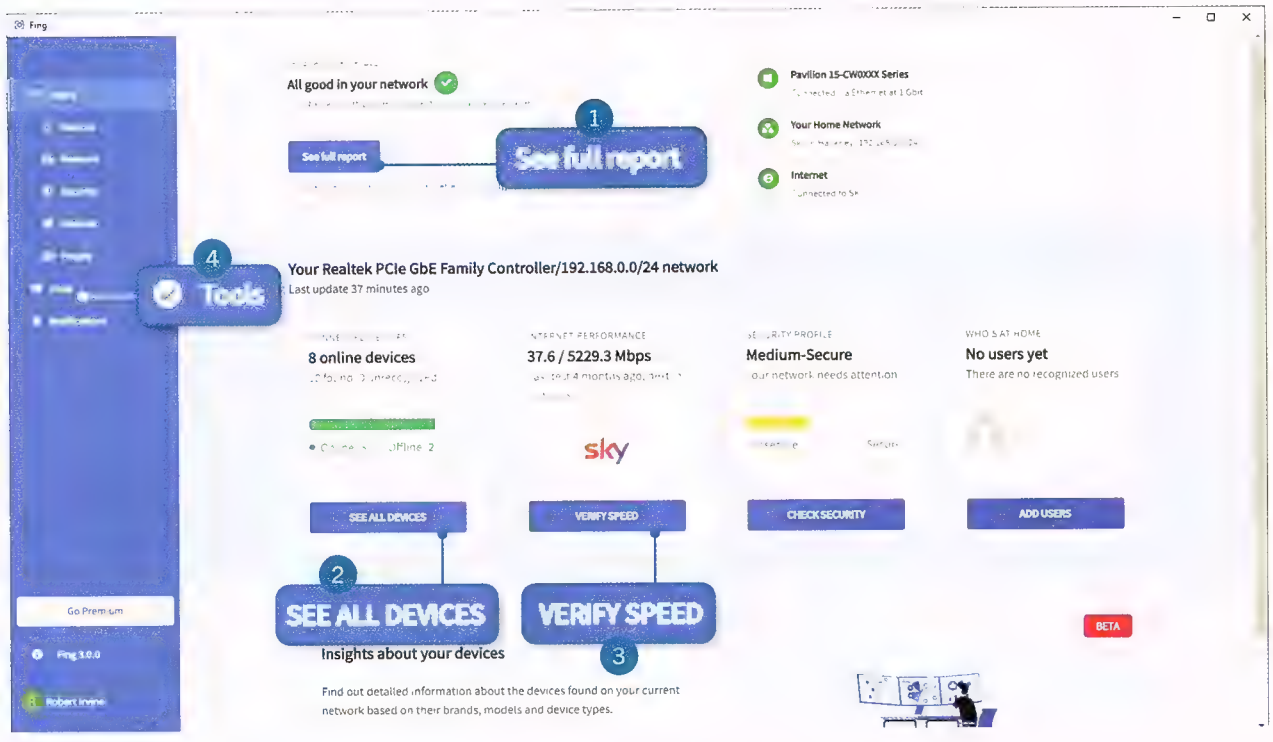
Fing Desktop provides a simple way to monitor your home network and ensure that you're getting a fast and reliable connection from your internet provider. Last time we looked at the program, we were rather underwhelmed, so we're pleased to report that version 3 is a major improvement that addresses most of our concerns.

Fing's interface has been redesigned to place a wealth of useful info on your Home dashboard. This includes summary cards showing the status of your connected devices, your internet performance and the level of your Wi-Fi protection. Each card includes a button you can click for further details – for example, click 'Verify speed' to test your current download and upload speeds. You can also view a full report of all the devices on your network based on their type, brand and model.

Another welcome change is to the program's Tools tab, which now organises options for diagnosing problems into logical sections such as 'Troubleshoot your network'. Even better is that several tools that previously required a Fing Premium subscription (US$4.99 a month) are now available to all free users. These include scanning your network for open ports, performing a DNS look-up and checking your Wi-Fi access points. We particularly like the Detect Outages option, which tells you about any reported problems in your area, not only for your own ISP but other internet providers – handy for helping friends and family who have been knocked offline. You can also compare the average speeds and customer ratings of different ISPs.

Some of Fing Desktop's best features are still limited to its paid-for version, such as scanning for router vulnerabilities, but the free edition is slicker and smarter than ever. You need to register with Fing to use the software, but can sign in using your Google or Apple account.

> "Last time we looked at the program, we were rather underwhelmed, so we're pleased to report that version 3 is a major improvement that addresses most of our concerns."



1 When you launch Fing Desktop, it runs through a series of checks to ensure your network is running smoothly and informs you of any connectivity problems. Click 'See full report' for more information.

2 Fing detects how many devices are currently connected to your home network and whether they're online or offline. Click the 'See all devices' button for a full list and make sure you recognise all the entries.

3 Click the 'Verify speed' button then choose 'Test speed' and Fing Desktop will test your download and upload speeds. It will then tell you how the results compare with other internet providers in your area.

4 The Tools section features plenty of useful options, most of which are now free to use. These include a Detect Outages tool that informs you about ISP problems in your area, and a tool for looking up DNS addresses.

Various licences available | www.dragonflybsd.org

DRAGONFLYBSD 6.2.2

David Rutland takes a long and confusing journey to the land before time, where things look familiar... but aren't.

Dragonflies are glittering and gorgeous relics from another age. With a sheer size that distinguishes them from other less-dazzling insects, they zip, helicopter-like, in straight lines – defending their territory, and searching for food.

Dragonfly is also a distro, and unlike the majority of distros found in the hot, savage jungles, it isn't a Linux one. It is, instead, part of a tiny and oft-overlooked subset straight from the Jurassic era of OS development, a BSD-based distro.

Forked from the primordial soup of FreeBSD in 2003, DragonflyBSD shares code with other BSD OSes, and boasts natively written AHCI and NVMe drivers, HAMMER, which is a "modern high-performance filesystem with built-in mirroring and historic access functionality", and according to the devs, suffers, "virtually no bottlenecks or lock contention in-kernel". Which is exactly what you'd expect from an armour-plated flying machine.

Releases drop twice yearly, and are only available for 64-bit systems. If desktop environments are your thing, Dragonfly is compatible with Awesome, Cinnamon, Fluxbox, JWM, KDE, LXDE, MATE, Openbox, WMaker and Xfce.

Booting from USB, you'll be greeted with some nice ASCII art of a dragonfly, and after a few seconds, given a log-in prompt. You can either log in as root or, if you want to install Dragonfly to your system, you'll need to log in with the username installer. This is a neat approach, but requires that you actually read the text on the screen. Choose installer to make your way through the ncurses-style progression of options, and eventually you'll be asked to choose a filesystem. Your options are limited here, and it's unlikely that many Linux users will recognise UFS (Unix File System – a distant relative ext2), nor will they be familiar with HAMMER1 (the filesystem used by previous Dragonfly iterations), or HAMMER2, (the most recent version). Go with the default partitions and you'll be warned about the speed at which HAMMER filesystems fill up, and briefed on methods of pruning and freeing up space. There are exclamation marks, and it's all very scary to someone new to the BSD world.

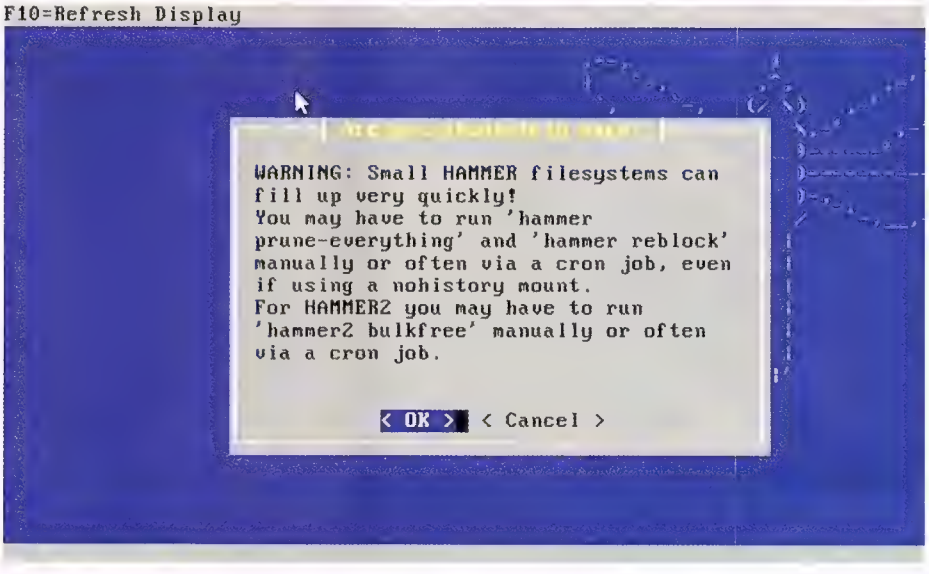
> "Dragonfly is also a distro, and unlike the majority of distros found in the hot, savage jungles, it isn't a Linux one."

Select configure system to set locale, users, passwords, home directories, network interfaces, hostnames and so on. After this, users who haven't thoroughly read the online documentation may be left even more confused. You'll need to search through the website for the term 'how to get to the desktop'. You'll find the info you need along with the unhelpful caveat that 'This topic is wildly out of date'.

You'll need to update your system, and then install XOrg, your desktop environment, a login manager, and other essential utilities such as sudo and a package manager, from the command prompt. This isn't always as straightforward as you'd imagine because no active repositories are configured, and you'll need to manually copy repo config files from the ISO to the disk.

In short, installing DragonflyBSD isn't intuitive, and you may have to consult resources beyond the online docs. You'll get there in the end though, and be greeted with whatever DE you chose. After a gruelling trek through the swamps of the installation, the familiar look and feel of an Xfce desktop will feel like home.

As a BSD-based system, DragonflyBSD is hugely customisable – and by necessity, you'll have done much of the customisation during the install process. It's a hard journey, and when you get there in the end, it looks like Linux, but it isn't.


F10=Refresh Display
WARNING: Small HAMMER filesystems can fill up very quickly!
You may have to run 'hammer prune-everything' and 'hammer reblock' manually or often via a cron job, even if using a nohistory mount.
For HAMMER2 you may have to run 'hammer2 bulkfree' manually or often via a cron job.
< OK >
< Cancel >

There's no point showing you a standard Xfce desktop, so here's a snap (not the Canonical sort) of the installer instead.

Dragonfly is fine, we guess. When it eventually let us into a DE, everything worked as it should. We're exhausted.

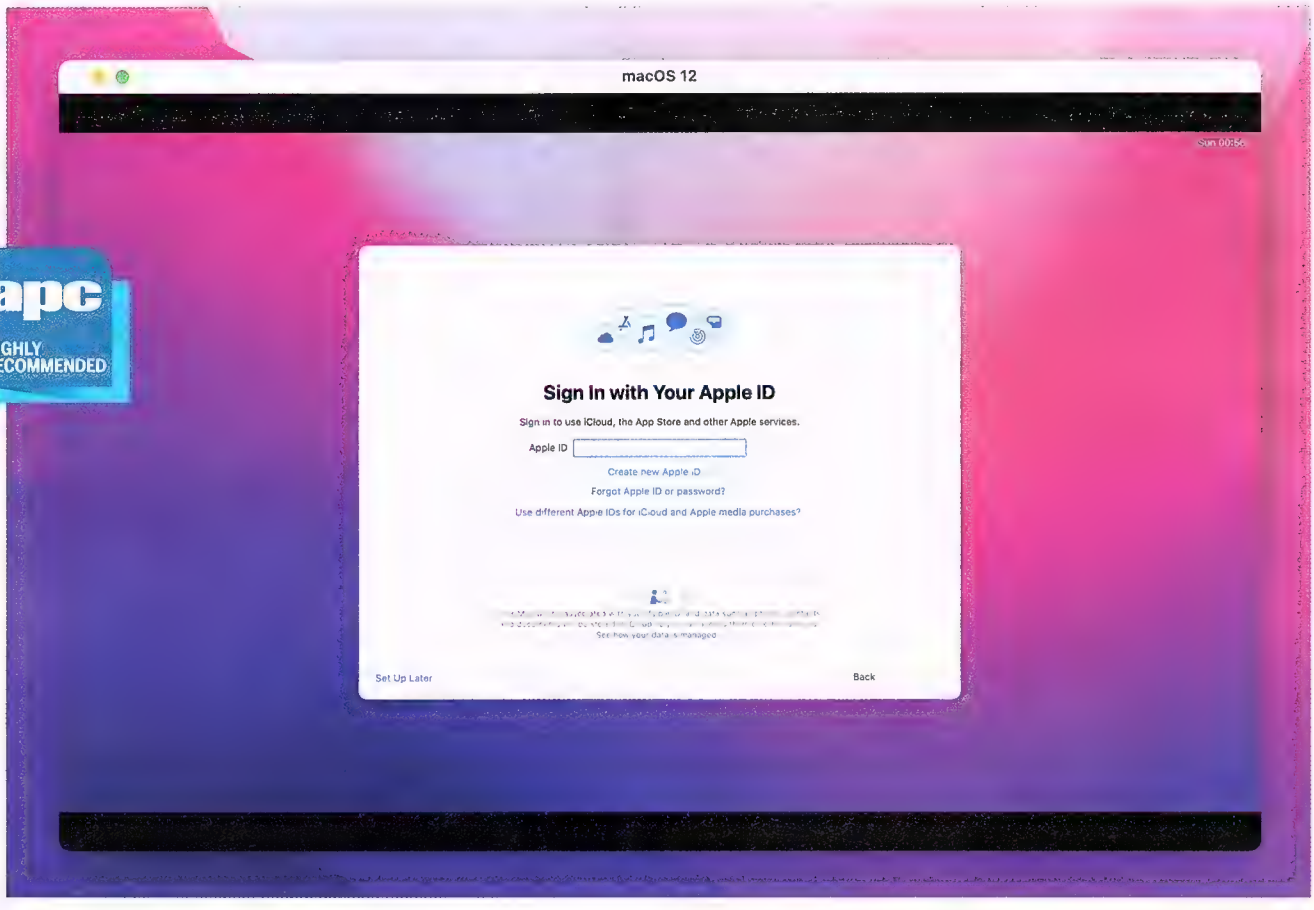
Mayank Sharma

★★★☆☆

macOS 10.14 or later, 4GB of memory | From $139; upgrades $99 | parallels.com

PARALLELS DESKTOP 18

Digital note-taking with a creative human touch.


macOS 12
Sign In with Your Apple ID
Sign in to use iCloud, the App Store and other Apple services.
Apple ID
Create new Apple ID
Forgot Apple ID or password?
Use different Apple IDs for iCloud and Apple media purchases?
Set Up Later
Back

apc HIGHLY RECOMMENDED

Installing macOS on an Apple silicon Mac invites you to sign in with your Apple ID, but it can't see it through.

A year ago, Parallels delivered the first virtualisation app to make full use of Apple silicon Macs, including Monterey virtual machines (VMs). Five new Mac models later, including the first M2 Macs, Parallels Desktop 18 remains the only commercial app to run macOS as a guest on those Macs.

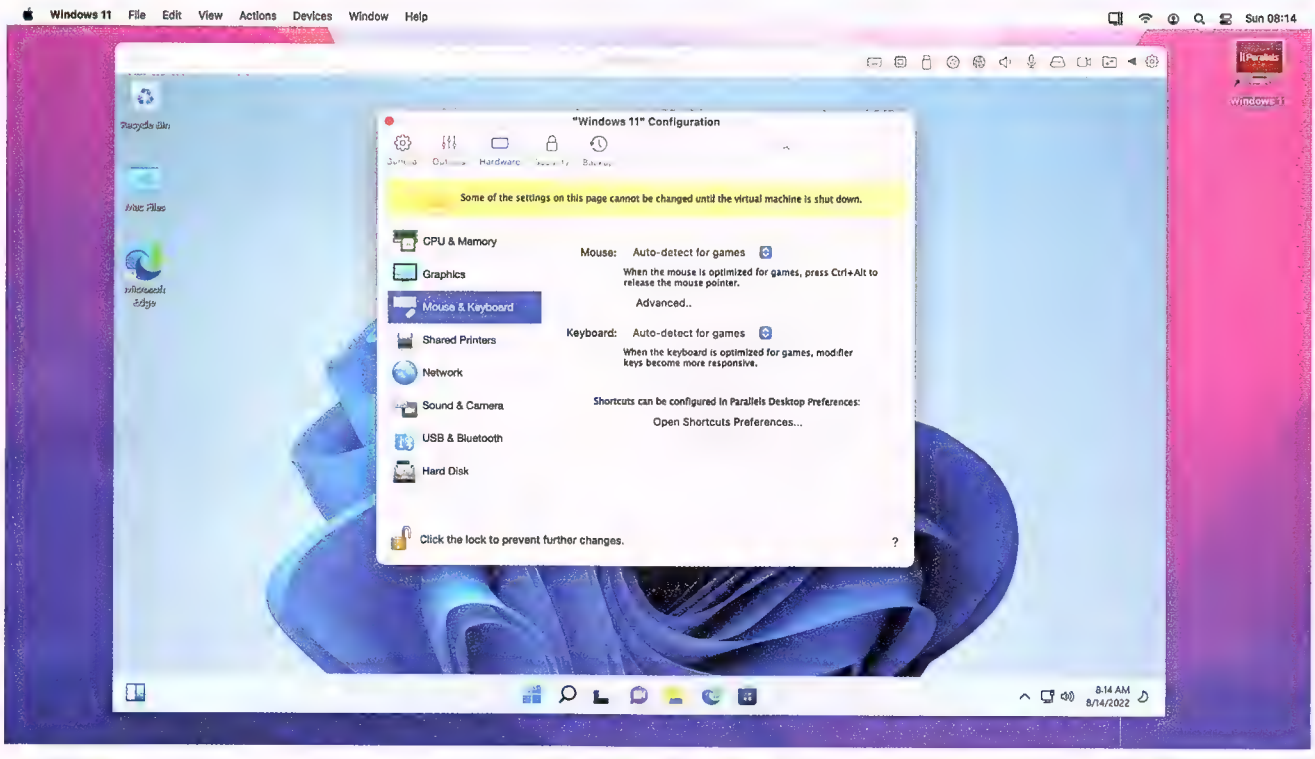
Unlike open-source rival UTM, Parallels can't emulate different architectures: it runs ARM guests on Apple silicon Macs, and Intel x86 guests on Intel Macs. On Apple silicon Macs, this new version continues to virtualise Windows 10 and 11 for ARM, four Linux distros for 64-bit ARM processors, and macOS from Monterey onwards, but not Big Sur. On Intel Macs it will virtualise Windows from XP and earlier to 11, almost any Linux distro using Intel kernel 2.6.29 or later, macOS from 10.7 to 13, and a few others including Solaris, BSD and a special version of Android.

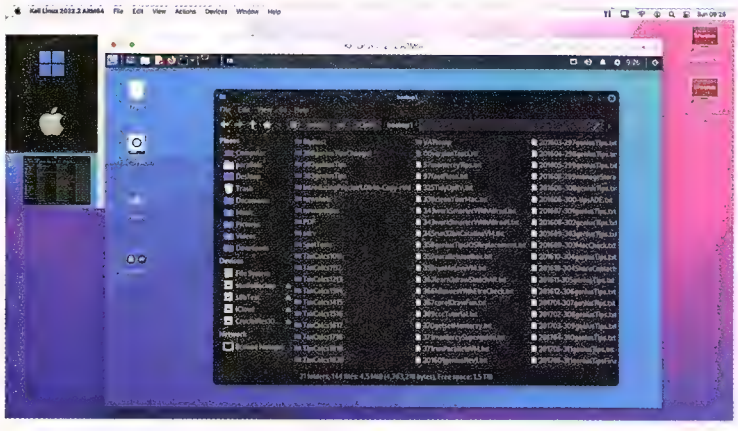
Intel Macs are effectively just a special design of PC, so virtualising the many operating systems available for their processors isn't such a great technical challenge. Apple silicon Macs are so different that an alternative approach is required. Parallels has worked with Apple on a solution based on a standard already used in Linux, using Virtio (for virtual input/output) devices. These must be built into the guest operating system to connect with a device in the host macOS, so replacing hardware-specific device drivers in a new software framework. Apple has changed Monterey and Ventura to support these devices as both guest and host, which is the reason that Apple silicon Macs can't run Big Sur in a VM.

For VMs running on ARM Macs this enables almost all code to run at full speed. Apple's special display device also supports Metal and GPU acceleration, delivering performance as good as native macOS. Like other apps using these new features in Monterey and Ventura, Parallels Desktop 18 provides excellent compatibility and speed, and supports the translation of Intel-only apps using Rosetta 2, but it's limited to the devices supported by macOS.

Strangely, Apple decided that this doesn't include connecting to any service requiring an Apple ID, preventing macOS VMs from any access to iCloud services, syncing, or iCloud Drive. As App Store connections also rely on your Apple ID, macOS VMs can't run any third-party or paid-for apps from the App Store, although Apple's free apps like Pages and Numbers still work normally. While Apple could change its mind for Ventura, Monterey VMs are probably never going to be able to run most App Store apps, a severe limitation for many potential users.

Some features in this new


Windows 11 File Edit View Actions Devices Window Help
Sun 08:14
"Windows 11" Configuration
Some of the settings on this page cannot be changed until the virtual machine is shut down.
CPU & Memory
Graphics
Mouse & Keyboard
Shared Printers
Network
Sound & Camera
USB & Bluetooth
Hard Disk
Mouse: Auto-detect for games
When the mouse is optimized for games, press Ctrl+Alt to release the mouse pointer.
Advanced..
Keyboard: Auto-detect for games
When the keyboard is optimized for games, modifier keys become more responsive.
Shortcuts can be configured in Parallels Desktop Preferences:
Open Shortcuts Preferences...
Click the lock to prevent further changes.
8:14 AM
8/14/2022



Above: Windows 11 for ARM virtual machines have extensive options to support devices including games controllers.
Left: Standard Linux distros like Kali are simple and quick to install, and have full iCloud access.

support for Virtio devices aren't available in Monterey, only in Ventura. The most irksome is a lack of shared folders to exchange files between macOS guests and the host, which requires a Virtio file system available in Ventura but not Monterey. The simplest way to work around this is using by file sharing and virtual networking, which is clumsy and slow. Shared clipboards also don't work in Monterey, preventing copy and paste between guest and host. Users needing to change a guest's secure boot settings, perhaps to disable SIP, require Ventura as the host, as entering Recovery mode isn't supported on Monterey hosts. More embarrassing for Parallels is its continuing failure to provide GUI controls for macOS VMs on Apple silicon Macs, which still have to be set up by editing a text configuration file.

Start Parallels Desktop 18 on Apple silicon to be drawn straight into downloading and installing Windows 11 for ARM without joining Microsoft's Insider Preview programme. Licensing Windows for ARM remains complex and controversial: some claim all you need to do is buy a valid Windows licence to make your VM legitimate if unsupported by Microsoft. Larger enterprises need to check their standing, as Windows 11 for ARM isn't sold by Microsoft, and officially remains available only through its Insider Preview programme.

Intel apps

Parallels Desktop 18 improves the compatibility of Intel apps running in Windows 11 for ARM, in particular in file access to disk to resolve problems saving files from Microsoft Office to Shared Folders, and *Counter-Strike: Global Offensive* now runs. Parallels claims only 0.01 percent of Intel apps remain unable to run on Apple silicon Macs.

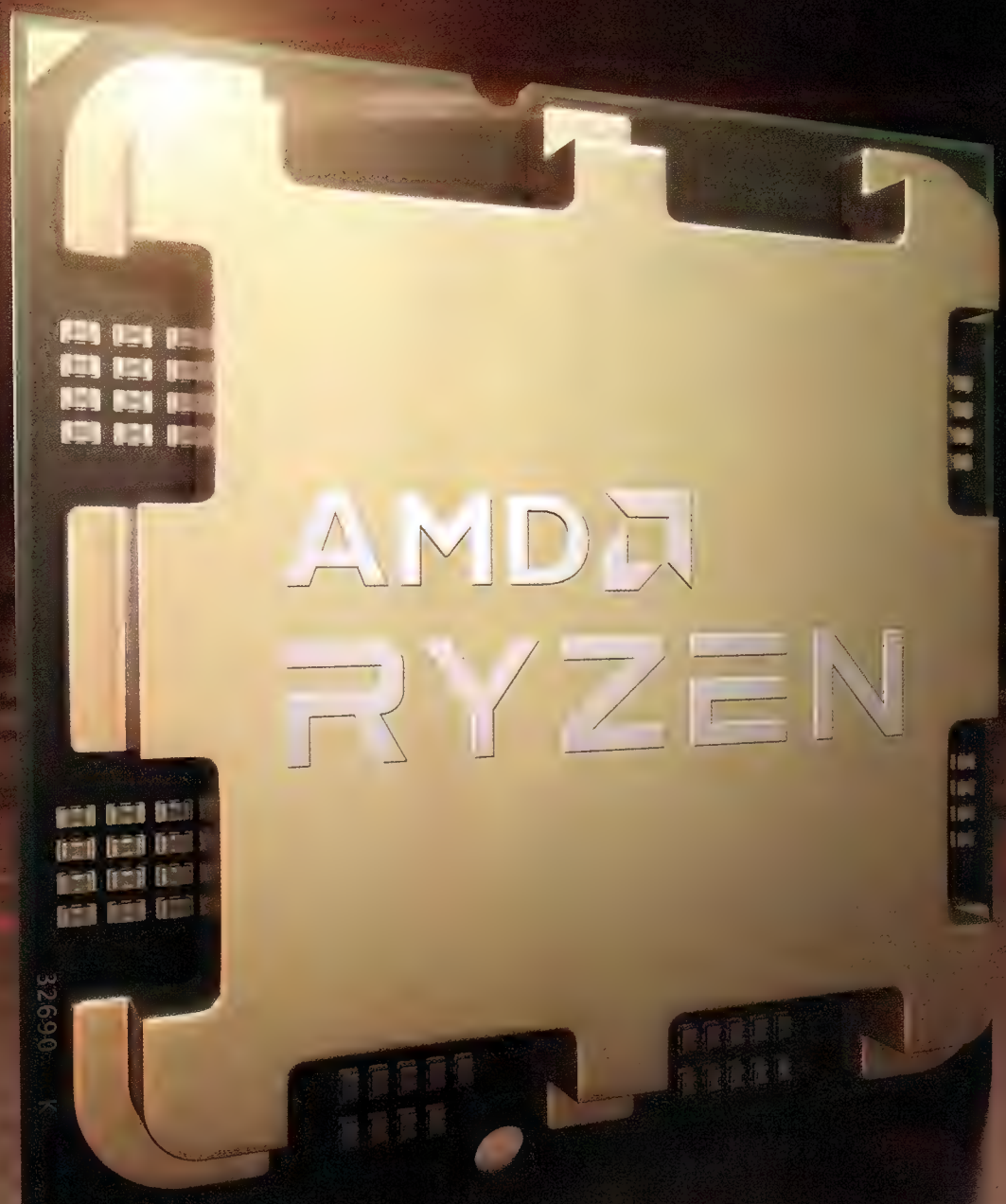
If you're fortunate enough to own an M1 Ultra-powered Mac Studio, you can give your Windows 11 VM more memory and cores: Parallels Desktop Pro and Business editions can virtualise up to 62GB of memory and 18 cores to unleash the full speed of Windows 11. All editions can sync with and benefit from ProMotion display refresh rates when set in the host's Display pane. There are also improvements in USB 3.0 support for live streaming devices, and for game controllers.

Parallels Desktop 18 is a worthy upgrade, and the best choice if you want easy access to macOS, Windows and Linux on modern Macs. But virtualising macOS on Apple silicon Macs still has drawbacks that won't all be resolved with Ventura.

The best virtualiser giving easy access to Windows 11 and Linux on Apple silicon, but still limited when running macOS

Howard Oakley

★★★★☆



AMD RYZEN 7000

ZEN 4 TAKES AMD BACK TO THE TOP STEP, AS CHRIS SZEWCZYK EXPLORES THE NEW-GEN CHIPS.

It's upgrade season! Whether you're after a new CPU or GPU, the rest of 2022 is packed full of exciting new hardware releases. The first of these big launches is AMD's much hyped Ryzen 7000 CPUs. They're accompanied by X670 motherboards with the new AM5 socket. More affordable B650 motherboards will follow later.

Zen 4's performance improvements lead AMD to believe its range delivers class leading single and multithreaded performance, performance per watt and value for money. But before we get to the 16-core 7950X and 8-core 7700X CPUs we have on hand for reviews, let's take a closer look at the Zen 4 architecture.

Under the hood

Central to the new range is a redesigned front end, with improved branch prediction, larger op and data buffers, larger integer and floating-point registers and a doubling of L2 cache per core, from 512KB to 1024KB. These combine to give what AMD claims is an average 13 percent IPC improvement. Though that's far from the only Zen 4 improvement. Zen 4 brings AVX-512 support, giving AMD an advantage over Intel's 12th Gen and upcoming 13th Gen processors that lack AVX-512.

Clock speeds have received a huge increase. In the case of the 7590X, the peak boost clock is as high as 5.7GHz, a huge 800MHz increase. So, combining a 13 percent IPC uplift and up to 16 percent clock speed increase delivers up to 29 percent single core performance gain with even higher multi-core performance. But there is a cost for that clock speed increase. Compared to Ryzen 5000, AMD has raised the base TDPs of several 7000 models, up to 170W for the 7900X and 7950X, and 105W for the 6-core 7600X. The 7700X remains unchanged at 105W. This means cooling requirements are higher. However, you can opt to use AMD's Eco mode if you choose, which allows you to configure the processor to a lower TDP. You can even set a 7950X to 65W!

The physical makeup of the range is mostly unchanged, with up to two Core Complex Dies (CCDs), each containing up to eight cores, plus an I/O die. The CCDs are built on TSMC's 5nm process, and they clearly benefit from the superior characteristics of the new process. Additionally, the I/O die is built with the TSMC 6nm process, this compares to Zen 3's 14nm I/O die. In fact, the I/O die receives perhaps the biggest upgrades for this generation.

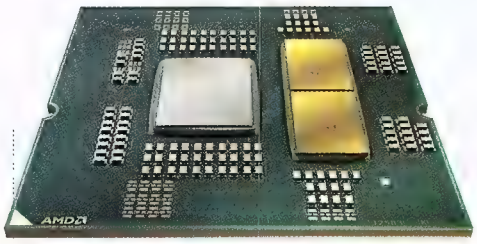
The space savings delivered by the smaller I/O die meant there was enough room for AMD to include integrated graphics, and that's' a very welcome inclusion. It's not there to provide beyond anything but the most rudimentary of gaming capabilities though. It's far less powerful than the IGP of AMD's mobile parts or APUs, but it does offer AV1 decode, DP 2.0 with USB type-C support, and HDMI 2.1. Depending on motherboard support, this means office and productivity PCs won't require a discrete graphics card.

Zen 4 introduces DDR5 support to AMD desktop processors for the first time. DDR4 support is not provided. This means AMD upgraders will have to face some financial pain, which was going to be an inevitable trade off after many years of AM4 upgradeability. AMD promises support for AM5 until at least 2025.

> "AMD says it expects AM5 to have a long life much as AM4 did"

AMD introduces its own standard for automatic memory profiles, called EXPO. It's mostly similar to Intel's XMP standard, but it's tuned to suit Zen 4 processors. Though XMP will remain supported, AMD users should choose EXPO wherever possible in order to apply optimised sub timings.

PCIe 5.0 support is another significant addition. All 7000 series processors feature 28 (16 + 8) PCIe 5.0 lanes. Primary slots will typically be configured in a 16x or 2 x 8x configuration, with up to 2 x 4x lanes for PCIe 5.0 NVMe drives. though configurations will vary by chipset and motherboard.



AMD says Zen 4 processors will happily run at 95 degrees before throttling. That might be hard for enthusiasts to accept but we'll take AMDs word that this will be safe in the long term. Still, you'll want a good AIO for a 7900X or 7950X and a good tower cooler for a 7600X and 7700X.

Our readers will be aware of AMD's 5800X3D V-Cache model. The good news is, AMD hasn't abandoned the tech and will introduce one or more V-Cache equipped 7000 models in the future. Given the gaming prowess of the 5800X3D, 7000X3D models are well worth keeping an eye out for.

Introducing Socket AM5 – AMD goes LGA

Accompanying the launch of Ryzen 7000 CPUs is a new socket – LGA 1718, popularly known as AM5. It replaces the venerable AM4 socket and its changes from a PGA socket to an LGA one, meaning the pins are now on the motherboard instead of the CPU. It supports DDR5, PCIe 5.0 and includes expanded USB support, more general purpose PCIe lanes and improved power delivery capabilities. AMD says it expects AM5 to have a long life much as AM4 did, so a good quality AM5 motherboard should be capable of supporting Zen 5 and Zen 6 models, and maybe even beyond.

AM5 motherboards will consist of X670/E and B650/E motherboards. X670E versions include PCIe 5.0 expansion slots while the non-E version does not. However, both versions include PCIe 5.0 M.2 slots. Specific implementations will depend on the motherboard. High end motherboards are more likely to be X670E models. And they're very expensive in part because of the high-quality signaling required for full PCIe 5.0 support.

B650 is the budget-oriented chipset, and like X670 there are two versions. B650E supports PCIe 5.0 slots for expansion cards plus lanes for NVMe SSDs, while B650 will support PCIe 4.0 only on both its expansion and M.2 slots.

So, we've got powerful new CPUs and a brand new and feature rich – albeit expensive – motherboard platform. Read on as we review the flagship 16-core Ryzen 9 7950X and its little brother, the 8-core Ryzen 7 7700X. We've also got a selection of X670 motherboards on hand from Asrock, Asus, Gigabyte and MSI.

CPU

AMD Ryzen 9 7950X

Retaking the performance crown

■ $1,209 | www.amd.com

■ AMD Ryzen 9 7950X; AM5 socket; 16 cores / 24 threads; Base/Max Clock Speed 4.5/5.7GHz, 64MB L3 Cache; 2CU RDNA 2 integrated graphics; 170W TDP, 230W max socket power.

Say hello to the flagship CPU of AMD's Ryzen 7000 range, the Ryzen 9 7950X. It's got the most cores, and the highest clocks and its aim is to deliver the both the best single threaded and multi-threaded performance of any x86 CPU released to date.

The 7950X is a 16 core, 32 thread CPU with 64MB of L3 cache and a 170W TDP. That's some 65W higher than the 5950X. AMD has extended the total package power to 230W. So while the 7950X is a very fast CPU, there is an efficiency cost involved. As a result, AMD recommends a 240mm or 280mm cooler to keep the 7950X performing at its highest boost clocks.

Speaking of boost clocks, they are seriously impressive and a big step forward over what the best Zen 3 chips were capable of. The 7950X's base clock is 4.5GHz while the peak turbo clock reaches as high as 5.7GHz. That sounds impressive, and genuinely it is, but it means the chip runs hot as well as consuming more power. AMD says the 7950X, and other Zen 4 chips are able to run at 95 degrees without any issue. If it reaches that, it will start to lower the boost clocks. Even with a 360mm cooler, our chip was still hitting over 90 degrees under heavy loads. We'll trust AMD when it says Zen 4 is happy to run at such temperatures.

Additionally, the 7950X, and all other Ryzen CPUs released to date include integrated RDNA2 based integrated graphics. Officially, it supports memory of up to DDR5-5200, though of course it can run much faster than that, though DDR5-6000 is the performance sweet spot.

> "If time means money, there's nothing better outside of the Threadripper Pro"

The 7950X performs extremely well. The IPC and clock speed increases make it the fastest desktop CPU of all. When it comes to multi-threaded workloads, it's in a league of its own. Its high turbo speeds mean it's more than capable in lightly threaded loads too, though when it comes to gaming it's more of a mixed bag. There are a few reasons for that. The single CCD configuration of the 7700X gives it an advantage over the 7950X, while some game engines simply aren't specifically optimised for very high core count CPUs, which are still few in number compared to the masses of four and six core CPUs out there.

At $1,209, AMD is asking a lot for the 7950X, but given the deteriorating AUD to USD exchange rate, We think that's a reasonable price for a processor that packs in this much performance. Though with the high cost of X670 motherboards and the need to buy DDR5 memory, it's still a costly overall upgrade.

As a prosumer CPU, the 7950X is simply amazing. If time means money to you, there's nothing better outside of the much more expensive Threadripper Pro range. However, if you're a gamer, one of the lower core count options will perform just as well, while letting you divert money towards a better GPU.

The imminent launch of Intel's competing 13th Generation chips may shake things up yet again, but for now the mighty Ryzen 9 7950X returns the performance crown to AMD. We'll find out soon enough whether it can keep it.

If you're looking for the fastest all-round CPU and especially have the software to make use of all of those threads, the 7950X is your CPU.

Chris Szewczyk

★★★★½

CPU

AMD Ryzen 7 7700X

The Zen 4 CPU for gamers

■ $689 | www.amd.com

■ AMD Ryzen 7 7700X; AM5 socket; 8 cores / 16 threads; Base/Max Clock Speed 4.5/5.4GHz, 32MB L3 Cache; 2CU RDNA 2 integrated graphics; 105W TDP, 142W max socket power.

The Ryzen 7 7700X is poised to become the Zen 4 sweet spot CPU. With 8 cores and 16 threads, it looks like it should offer a good blend of performance, efficiency and value for money. At least that's AMD's hope! At $689 it's a step up in price from the outgoing 5800X, which you can get for around $450 right now, but in time, we'd expect the 7700X to drop down.

The naming of the 7700X is a little curious. Perhaps AMD is saving 7800X branding for a future 3D V-cache model? That would make sense.

The 7700X contains the aforementioned 8 cores and 16 threads. It comes with a 4.5GHz base and 5.4GHz boost clock. That's a full 700MHz more than the 3.8/4.7GHz of the 5800X. It keeps the same 105W TDP with a 142W maximum turbo power. It will happily use that higher figure if you let it. Don't forget the underrated Eco mode if you want to drop power and temperatures a little. At its default settings, AMD recommends the use of a good quality tower air cooler at a minimum.

On to the numbers! The 7700X destroys the 5800X in anything multi-threaded and offers a very healthy lightly threaded lift too. The higher clocks and improved instructions per cycle (IPC) really stand out. It's not enough to close the gap to the higher core count 5900X, which remains an option if your workloads can make use of its 12 cores and 24 threads.

Compared to Intel's 12th Gen models it easily sees off the 10C/16T 12600K, even though the 12600K is now a much cheaper CPU. The 12700K is a very strong competitor.

The 7700X is the best Zen 4 gaming CPU. Even though it's clocked a little lower than the 7900X and 7950X, the 7700X is a better choice, while costing less. Its single CCD design means all data is processed on one die, which helps latency sensitive applications like gaming. Intel's 12th Gen CPUs are no gaming slouches either, but there's another contender, the one-off Ryzen 5800X3D. It is still a very good gaming CPU, and if you've got a compatible AM4 motherboard, it's a cost effective one too. We look forward to seeing Zen 4 X3D models in the months ahead. If you're a mad keen gamer, you'll want to wait for them.

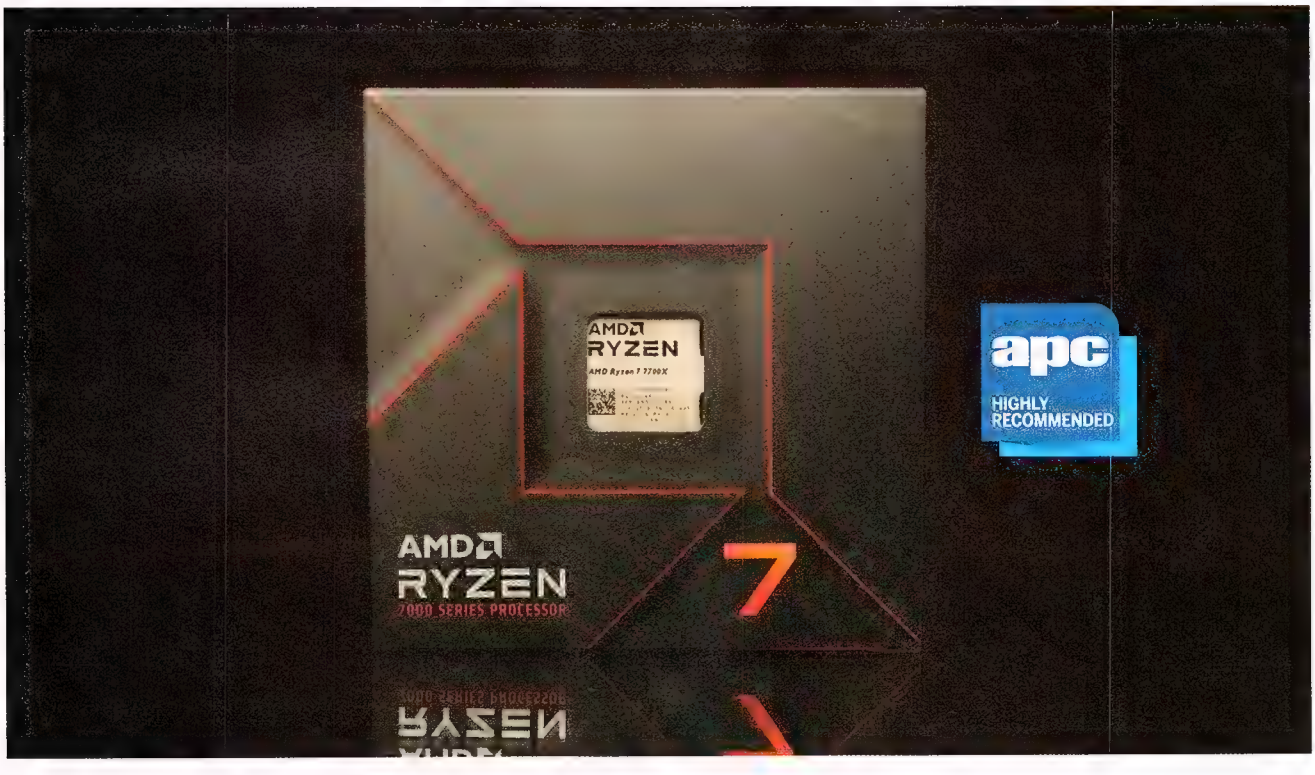
By itself, the 7700X is an excellent CPU, but it does require the purchase of a new motherboard and DDR5 memory which adds significant non-optional cost. There's also the imminent launch of Intel's 13th Generation range. They're set to up their thread counts, providing a tougher fight than the 12th Gen range. An X3D version is in the works, which should appeal to gamers.

That's a story for another day though. Right now, the 7700X is a strong all-rounder, offering a combination of excellent multi-threaded and gaming performance while keeping the efficiency that Ryzen CPUs have always been known for. However, AMD's own 5800X3D and Intel's Core i7-12700K are formidable options. The 7700X is an excellent CPU, but it needs to drop a little in price if it's to offer strong value on top of its high performance.

The Ryzen 7 7700X is an excellent CPU, but its high platform cost increases the appeal of other options around this price point.

Chris Szewczyk

★★★★☆



MOTHERBOARD

Asrock X670E Taichi

Taichi evolved.

■ $1,029 | www.asrock.com

■ Asrock X670E Taichi; AM5 socket; 4x M.2; 8x SATA; Up to 2x USB 4, 1x USB 3.2 Gen2x2, 5x USB 3.2 Gen 2, 7x USB 3.1 Gen 1, 4x USB 2.0; 1x HDMI 2.1; Killer Wi-Fi 6E; Killer E3100G 2.5G LAN; Realtek ALC4082 7.1 Channel HD Audio; ATX Form Factor.

When Asrock's Taichi brand made its debut, it was welcomed as a solid mid-range alternative in an era of excessive RGB and 'gamerification'. But these days, the Taichi has evolved into a flagship product, packed with premium tier features.

The X670E Taichi's cyberpunk theme looks as good as ever. Its splashes of gold colouring and mechanical cogs on top of an overall black design really looks good. To me personally anyway. Looks are always subjective.

As it's an X670E board it comes with PCIe 5.0 slots, with one 1x16x or 2x8x plus another four lanes for a PCIe 5.0 M.2 drive. Asrock calls this slot 'Blazing M.2'. The Taichi comes with a very large heatsink with an embedded fan. That's as good an indicator as any that PCIe 5.0 drives are going to be very hot. On top of the total of four M.2 slots, you get eight SATA ports. That makes this a good option if you're looking for lots of storage potential.

Are you after a powerful VRM? It doesn't get much better than this on any consumer motherboard. 24+2+1 phases with 105A stages is overkill in truth and more than enough to power a 7950X with ln2 cooling. The heatsinks are weighty and solid, with lots of surface area. Under a sustained 7950X load, we recorded a peak temperature of just 49 degrees – an excellent result. There's a small internal fan, though we didn't even notice it until after pulling the system apart!

The rear I/O is a good one, with dual USB 4 ports being the highlight. You also get five 3.2 Gen 2 ports and three 3.2 Gen 1 ports. There's a PCI bracket if you wish to add another pair of USB 2.0 ports via a header. Networking duties are handled by Killer 2.5G and Wi-Fi 6E controllers. At over a thousand bucks, we'd like to see 5G or 10G LAN. The rest of the I/O panel is fairly standard, with HDMI and ALC 4082 driven audio. Asrock includes a good quality ESS Sabre 9218 DAC that's a clear step up from basic onboard audio.

When it comes to performance, the Taichi performed well enough, though it feels like it's a BIOS update or two away from reaching its full potential. Its multi-threading performance is a touch behind the others in the test. Despite keeping the CPU at under 95c, the Taichi all-core turbo clock was between 25-75MHz lower than the other boards at the same temperature. That would be enough to explain the small discrepancies. There was no such problem when it came to lightly threaded tasks or gaming, where the Asrock performed well.

The Asrock X670E Taichi looks every bit a premium product. Its forward-looking feature list is topped by those dual USB 4 ports, the ability to accept a PCIe 5.0 GPU and SSD without compromise and a top spec VRM and audio solution. The omission of 10G LAN is notable for a $1,000+ board and it feels like the BIOS needs a touch more work to allow it to perform at its best.

If you're after a feature packed board that will see you through a few generations of CPU upgrade, the X670E Taichi is well worth a look, even more so if its price drops to a more palatable level.

The X670E Taichi's forward looking features are notable but it needs that last one percent of BIOS polish to elevate it further.

Chris Szewczyk

★★★★☆

MOTHERBOARD

Asus ROG Crosshair X670E Hero

Asus' Hero steps up to the premium tier.

■ $1,189 | www.asus.com

Asus' ROG brand hardly needs an introduction. Since 2006, Asus ROG motherboards have rarely disappointed, and they continue to be popular with gamers and overclockers alike. But with premium hardware comes premium pricing, and at $1,189, the Crosshair X670E Hero is an expensive board.

At this price, you'd expect it to be packed to the hilt with features. And it is for the most part. Its M.2 complement stands out, with a total of five slots. Three of them are PCIe 5.0 compatible, and one of those is via a very well built PCIe 5.0 add-in card.

It's a good-looking board, with a large dose or RGB lit ROG branding atop the VRM heatsink. Its mirror-like middle section will be completely hidden by a large graphics card, meaning it's predominantly black and easy to blend in with just about any system theme.

Asus ROG boards always feature good VRM solutions, and the X670E Hero does too. It mightn't have the outright phase count of the Asrock or MSI, but don't let that bother you. The 18+2 phase VRM with 110A stages won't be remotely stressed by a heavily overclocked 7950X. The cooling is more than adequate too, if not quite as impressive as the MSI Ace's which features a much larger surface area thanks to finned heatsinks.

The rear I/O is a real strength of the board, with one exception. Again, you're limited to 2.5G LAN. At this price, at least 5G should be standard. That aside, the USB complement is about as good as it gets. 2x USB 4 ports are joined by a Gen 3.2 Gen 2x2 port and nine 3.2 Gen 2 ports. When combined with the internal headers, the board supports up to 23 USB ports!

■ Asus ROG Crosshair X670E Hero; AM5 Socket; 5x M.2; 6x SATA; Up to 2x USB 4, 2x USB 3.2 Gen2x2, 9x USB 3.2 Gen 2, 4x USB 3.1 Gen 1, 6x USB 2.0; 1x HDMI 2.1; Intel Wi-Fi 6E; Intel 2.5G LAN; Realtek ALC 4080 7.1 Channel HD Audio; ATX Form Factor.

"The X670E Hero felt like the most mature board of the bunch, along with the MSI"

The rest is mostly standard stuff for a high-end board. Wi-Fi 6E is now all but a standard inclusion, and there's a HDMI port for use with the new integrated graphics of Ryzen CPUs.

The BIOS of the X670E Hero follows the same layout that ROG boards have had for many years. It can be a bit daunting for newcomers but it's chock full of settings. If you like to play around, the Hero probably isn't going to miss out on much compared to upcoming overclocking focused boards. The X670E Hero felt like the most mature board of the bunch, along with the MSI.

The X670E Hero generally performed on par with the other boards. You can't read much into results that fall within a margin of error, though the Hero managed to do well at lightly threaded tasks.

Asus usually comes out the gates well when a new CPU and platform is launched, and that's again the case here. The BIOS feels mature, and though we haven't had a chance to really delve into things like the Eco mode and PBO, the boot time and memory compatibility seem to be good for a v1.0 attempt.

It's a solid offering, but – that price! Of course, a weak exchange rate bears some of the blame, but at $1,189, this is an expensive offering. If you don't mind the lack of 5G or 10G Ethernet, you'll be rewarded with a solid, reliable and well-built board that will surely last you through Zen 5 and 6 upgrades. At least that way you'll get your money's worth.

The Asus is a feature rich and refined board, but at $1,189 it's too expensive right now.

Chris Szewczyk

★★★★☆

MOTHERBOARD

Gigabyte X670 Aorus Elite AX

X670 can be done on a budget too. Relatively, that is.

■ $599 | www.gigabyte.com

■ Gigabyte X670 Aorus Elite AX; AM5 socket; 4x M.2; 4x SATA; Up to 2x USB 3.2 Gen2x2, 2x USB 3.2 Gen 2, 10x USB 3.1 Gen 1, 8x USB 2.0; 1x HDMI 2.0; AMD Wi-Fi 6E; Realtek 2.5G LAN; Realtek ALC 1220-VB 7.1 Channel HD Audio; ATX Form Factor.

Who said X670 boards were overpriced? This X670 (importantly it's the only non-E X670 in the roundup) is priced at a much more palatable $599. At half the price of the other reviewed models, does the Gigabyte Aorus X670 Elite AX have to sacrifice a little or a lot to come in at that price?

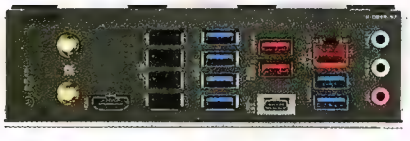
As a base X670 board, it drops PCI-e 5.0 slot support, while retaining a single PCIe 5.0 x4 M.2 slot. If that saves you hundreds of dollars. Apart from the chipset, the board still has four M.2 slots, including that single PCIe 5.0 one, a strong I/O, VRM and capable cooling. This is not some bargain bin cheapie.

The board isn't what we'd describe as beautiful. It seems to have various oddly matched metallic highlights, but it doesn't lack functionality, as the heatsinks are effective, particularly the VRM one, which would have been considered huge just a few years ago, though sadly Gigabyte opted not to include its excellent finned heatsink design on this model.

> "The Elite AX shows that manufacturers are getting a bit greedy at the high end"

The board comes with a 16+2+2 phase VRM with 70A power stages. Sure, it's not as beefy as the other boards in the roundup, but it's hardly a secret that the average user simply doesn't need to shove 1,000W or more into a CPU. Throw a 7950X with PBO enabled into the Elite AX and you won't have a problem. Your CPU cooling will give out before the VRM gets stressed.

So, the cooling, storage and VRM is more than enough, is the I/O lacking then? Hardly. It includes AMD's Wi-Fi 6E and Realtek 2.5G LAN. You'd expect to miss out on USB 4 at this price but the rest of the USB count is stellar. You get a 3.2 Gen 2x2 port, two Gen 2 ports, six Gen 1 ports and four 2.0 ports. That's 13 rear USB ports! S/PDIF audio would be nice but there's little to complain about with all of that.



When it comes to performance, the Aorus Elite AX was competitive in all areas, delivering strong gaming results in particular, though as always, it's worth noting that the differences between motherboards tends to be small.

As with just about every other board manufacturer since the debut of UEFI interfaces, aesthetic changes tend to be minimal. If we have a criticism, it's that the Elite AX's BIOS is a little feature light. For most users that won't matter. Once you enable XMP and install Windows, you might never return to the BIOS, but if you like to tweak, there are better options.

The Aorus Elite AX comes as a bit of a shock in this roundup. It's half the price of the other boards. It doesn't have the all out feature checklist of the others, but if you're someone who runs a single M.2 drive and GPU, then you'll lose next to nothing.

In fairness to the other manufacturers, they also have very competitive boards in this price range and they should not be overlooked. But, if nothing else, the Elite AX shows that manufacturers are getting a bit greedy at the high end of the market. Let's see what B650 has to offer in the weeks and months ahead.

The Gigabyte Aorus Elite AX is a true bargain at $599.

Chris Szewczyk

★★★★★

MOTHERBOARD

MSI MEG X670E Ace

Ultra luxurious with a price to match.

■ $1,399 | www.msi.com

■ MSI MEG X670E Ace; AM5 socket; 6x M.2; 6x SATA; Up to 3x USB 3.2 Gen2x2, 10x USB 3.2 Gen 2, 4x USB 3.1 Gen 1, 4x USB 2.0; AMD Wi-Fi 6E; Aquantia 10G LAN; Realtek ALC 4082 7.1 Channel HD Audio; ATX Form Factor.

If you thought the Asus Hero was on the pricey side, brace yourself. The MSI MEG X670E Ace is an eyebrow raising $1,399. Though you get a lot of motherboard, it's tough to accept that as normal, even if it's a monster of a board.

The MSI MEG X670E Ace is second only to the Godlike in MSI's motherboard range. Taking it out of its box, you're amazed at just how heavy it is! MSI retains the gold highlights of the previous Ace boards. Key highlights include up to six M.2 slots, with four slots on the board and another two PCIe 5.0 slots on an add-in card.

It's a small thing, but MSI deserves credit for its masterful primary M.2 slot installation method. It relies on a simple latch mechanism, and along with a screwless mounting, it's the best M.2 installation I've seen on any motherboard.

The Ace includes a 22+2+1 phase VRM with 90A power stages. Some other boards have 110A stages, but make no mistake, these boards are massively overbuilt, and even if Zen 5 or 6 processors double or more in TDP, the Ace won't even break a sweat.

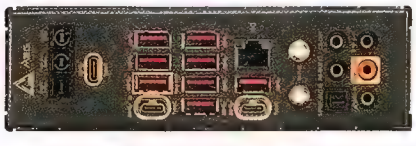
MSI has transitioned to a finned heatsink design, and we love it. It gives it a much larger surface area meaning cooling is never an issue. In our testing, it was barely warm, with a reading of only 45c. That's excellent.

> "It's the best M.2 installation I've seen on any motherboard"

The rear I/O is impressive, though it does lack USB4, which the cheaper Asus and Asrock have. You do get a pair of Type-C 3.2Gen 2x2 ports though, along with no less than nine 3.2 Gen 2 ports. The MSI is the only board in the roundup to include 10G LAN (thank you!). There's also an interesting button that MSI calls the Smart Button. It can be programmed in the BIOS to reset the system, turn the Mystic Light RGB on or off, boot into safe mode or set all the fans to run at full or default speed. Pretty handy that.

As we've been saying throughout the roundup, the boards all perform very similarly to one another, most of the time within a margin of error.

MSI's BIOS has changed little in recent years, and why would it? Its layout is more user friendly than that of the Asus, yet is still fully featured. At the time of writing, MSI released a new BIOS that allowed ECO mode to be set directly. If you don't like the idea of a 7950X pulling over 200W, you can set it much lower. Heck you can set it to 65W if you want. Expect other motherboard makers to roll out this feature in the weeks and months ahead.



Judging these boards is tough. I like the Ace a lot. It's got everything you'd realistically need apart from USB4. It runs cool, it's got some clever, innovative design features and it's got 10G LAN, but it's also $1,399 and that's going to stop most buyers from even considering it when decent Non -E boards, Including MSI's X670-P can be had for half the price. A few years ago, a $1,000 motherboard was considered ridiculous, but now it's no laughing matter. If you don't mind paying, the Ace really is ace.

With the exception of USB 4, the MSI Ace is packed full of smart features, but you'll have to shell out big bucks for it.

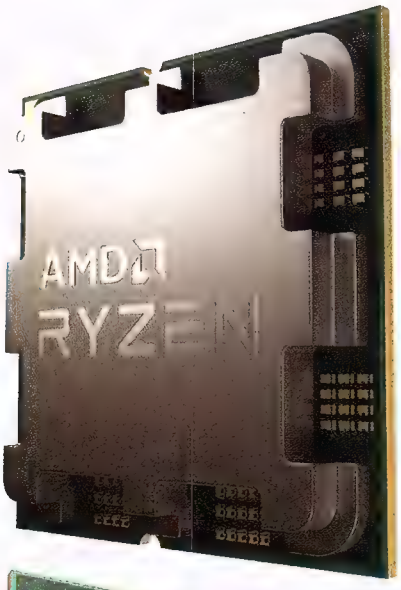
Chris Szewczyk

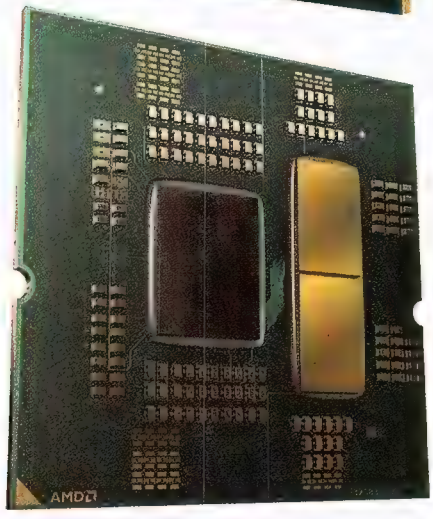
★★★★½

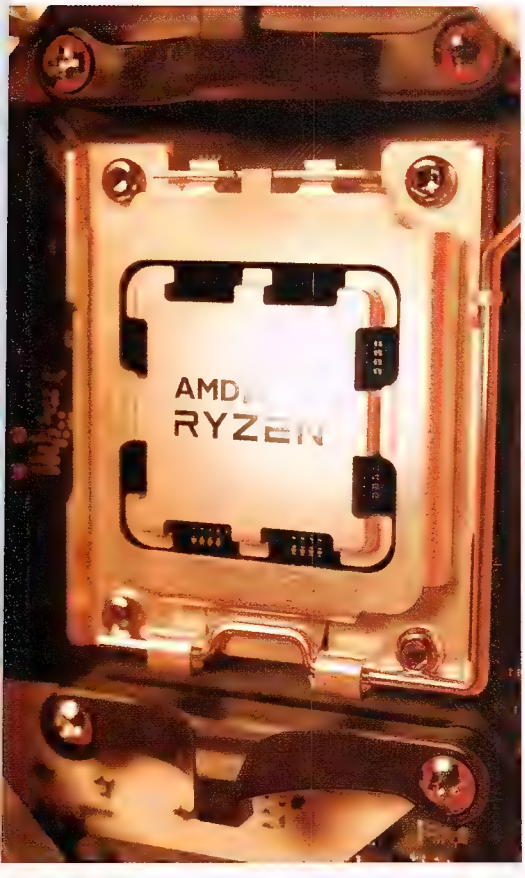
		AMD Ryzen 9 7950X	AMD Ryzen 7 7700X	AMD Ryzen 9 5900X	AMD Ryzen 7 5800X
Handbrake 1.5 Video conversion - 4K to 1080p FPS		84.7	67.3	59.2	53.7
Cinebench R23 Rendering - Multi thread (score)		38,384	19,810	21,311	15,795
Cinebench R23 Rendering - Single thread (score)		2,050	2,000	1,623	1,603
Blender 3.2 Whitelands Render Time (seconds) Lower is better		402	798	591	988
7Zip 22.01 File Compression - Billion Instructions per second		227.9	129.02	133.74	101.22
CPU-Z - Multi Thread Score		15,954	8,060	9,681	6,825
CPU-Z - Single Thread Score		802	776	686	674
Peak System Power Consumption - Wall Draw (watts)		352	238	219	216
PCMark 10 - Extended score		13,695	12,939	12,036	11,885
3DMark Storage Benchmark - score		3,318	3,367	3,367	3,393
3DMark TimeSpy Extreme	Overall score	10,579	9,598	9,820	9,189
	CPU score	13,053	6,814	7,615	5,685
Civilization VI	1080p, Ultra, DX12, Avg FPS	296	296	284	278
	1080p, Ultra, DX12, Min FPS	226	214	200	219
	1080p, Ultra, DX12, AI Turn Time	5.91	6.11	6.44	6.34
Ghost Recon: Breakpoint - 1080p, Low, Avg FPS		238	233	229	221
Metro: Exodus Enhanced Edition	1080p, Ultra, DX12, Avg FPS	133.2	136.0	128.1	127.0
	1080p, Ultra, DX12, Min FPS	63.2	70.0	76.6	75.6
F1 2021 - 1080p, ultra high Preset, Avg FPS		194	196	189	188

		Asus ROG Crosshair X670E Hero	X670 Aorus Elite AX	MSI MEG X670E Ace	Asrock X670E Taichi
Handbrake 1.5 Video conversion - 4K to 1080p FPS		84.7	85.4	85.1	84
Cinebench R23 Rendering - Multi thread (score)		38,384	38,296	38,114	37,904
Cinebench R23 Rendering - Single thread (score)		2,050	2,045	2,031	2,036
Blender 3.2 Whitelands Render Time (seconds) Lower is better		402	401	401	399
7Zip 22.01 File Compression - Billion Instructions per second		227.9	229.89	227.28	225.91
CPU-Z - Multi Thread Score		15,954	15,946	16,003	15,738
CPU-Z - Single Thread Score		802	791	783	791
PCMark 10 - Extended score		13,695	13,598	13,559	13,413
3DMark Storage Benchmark - score		3,318	3,386	3,363	3,301
3DMark TimeSpy Extreme	Overall score	10,579	10,613	10,559	10,571
	CPU score	13,053	13,220	12,940	12,880
Civilization VI	1080p, Ultra, DX12, Avg FPS	296	302	300	299
	1080p, Ultra, DX12, Min FPS	226	231	222	230
	1080p, Ultra, DX12, AI Turn Time	5.91	6.07	6.17	6.18
Ghost Recon: Breakpoint - 1080p, Low, Avg FPS		238	237	233	234
Metro: Exodus Enhanced Edition	1080p, Ultra, DX12, Avg FPS	133.2	133.7	132.2	132.1
	1080p, Ultra, DX12, Min FPS	63.2	70.9	67.7	68.7
F1 2021 - 1080p, ultra high Preset, Avg FPS		194	196	194	195

	AMD Ryzen 7 3700X	Intel Core i9-12900K	Intel Core i5-12600K	Intel Core i9-11900K
	46.7	79.6	64.1	51.9
	12,445	27,503	17,319	15,352
	1,305	2,022	1,873	1,622
	1,158	607	969	1042
	85.44	138.97	95.31	85.83
	5,641	11,427	6,961	6,525
	533	824	759	676
	156	341	222	318
	10,495	12,182	11,159	10,717
	3,209	3,469	3,474	3,202
	8,651	10,158	9,246	9,190
	4,557	9,269	5,845	5,892
	213	297	294	234
	192	223	201	198
	6.42	6.33	6.54	6.52
	191	234	222	198
	102.9	129.7	129.4	117.7
	63.9	68.9	66.9	69.4
	160	198	202	178







THE DAWN OF AN INCREDIBLE NEW ERA

So, there we have it! AMD kicks off a huge upgrade season with the very competitive Ryzen 7000 CPU series. Whether you're a gamer, a content creator or multi-tasker, there's a Zen 4 CPU to suit you. The competition never stands still though, and Intel is set to imminently respond with its 13th Generation range.

Unless you urgently need a new system, it's worth waiting to see what Intel brings to the table. AMD has also confirmed that it will release 3D V-cache models. If the 5800X3D is anything to go by, they should be gaming monsters. Perhaps AMD has missed a trick by not releasing a 7800X and marketed it as THE gaming SKU.

Accompanying the new CPUs is the new AM5 socket. Though we've covered several high-end models, it doesn't mean you have to shell out over $1,000 to get a high-quality motherboard. All vendors have more affordable X670 options, and if you are on a budget, there's the upcoming B650E and B650 range to consider.

The latter might be especially appealing if you've got your eye on an upcoming RTX 40 card or one of AMD's RDNA 3 graphics cards later in the year. It's an exciting time to be a hardware enthusiast. There's going to be so much to choose from. Zen 4 or 13th Gen? RTX 40 or RX 7000? Tough choices, but as PC enthusiasts, picking your parts is part of the fun.

A Ryzen 7000 series CPU and AM5 motherboard won't let you down, but the really exciting thing is that we're just getting started.

How high can you go? How about a massive 360Hz, as seen in the recent and very fabulous Acer predator X25.

FEATURE

Refresh rates 101

Bennett Ring takes a refreshingly honest look at one of the key selling points of today's displays.

"The absolute lowest refresh rate you'll find on a PC screen made in 2022 is 60Hz, which means that 60 individual images are drawn onto the screen every second, or once every 16.67 milliseconds."

Whether you're a gamer looking for the smoothest gameplay experience, or simply need your daily display to be easy on the eyes, one of the most important specifications is refresh rate. Referring to the speed at which a display's screen is updated, this area of technology is a minefield of misunderstanding. With the widespread adoption of HDMI 2.1a, along with TVs that now double as desktop monitors, it's become even more confusing. APC is here to bring you up to speed on what it all means.

What exactly is refresh rate?

When you're looking at the silky smooth motion of graphics or video on your display, you're actually looking at a series of static images being updated astonishingly quickly, one after another. The refresh rate of the display is the number of times per second that a new image is drawn, and is measured in Hertz, or HZ for short.

The absolute lowest refresh rate you'll find on a PC screen made in 2022 is 60Hz, which means that 60 individual images are drawn onto the screen every second, or once every 16.67 milliseconds. Meanwhile, your GPU outputs its own screens as frames per second (fps), with one frame being an entirely new picture. Until a few years ago, the screen's refresh rate and the GPU's frames per seconds often didn't match, unless vertical synchronisation was engaged (aka v-sync). We should point out that whichever is lowest – the screen's refresh rate or the GPU's outputted frame rate – will be the limiting factor. There's not much point in running a 144Hz display if your GPU is stuck at 60fps, as there is 84Hz of refresh rate headroom going unused.

You've probably heard the claim that anything over 24fps is a waste, as that's how film projectors used to work – they recorded the image at 24fps, and also played it back at 24Hz. Indeed, most TV shows and movies are still recorded at 24fps to this day. However, they use motion blurring within each frame to make this low frame rate and trick our eyeball's into seeing a smooth image, but this technique is impossible with a digitally created image.

Film and TV also employs clever camera techniques to hide the problem; watch a movie where the screen pans quickly over a large landscape and you'll easily see the stuttering caused by such a low frame rate.

The amazing eyeball

Our eyes don't work in the same binary on/off method as screens, but it turns out that the human eye can detect new information in as little as 1/1,000th of a second, provided it's just a flash of light, while fighter pilots have been able to identify an aircraft type shown in 1/255th of a second. Show a normal person a video game running at 60Hz versus 120Hz, and they should easily be able to spot the faster, smoother image. It's this clarity of motion that drives many gamers to strive for a high refresh rate display, but there's also the issue of responsiveness. As the illustration from Intel shows, a screen that is outputting a higher refresh rate (along with matching frames from the GPU) actually delivers more targets for a gamer to shoot in a given period of time.

At 120Hz the target is on screen every 8.33ms, but drop it to 60Hz and you halve the amount of time the target is accurately displayed. If you're competing for a $50,000 cash prize in a *Counter-Strike* tournament, it makes sense to go for a display and GPU that can hit higher frame rates. Asus recently demoed a 500Hz display aimed at this niche, but the trade-off is that it's only 1920 x 1080, and you'll need a beefy GPU that can also output that many frames per seconds.

Due to the static nature of most productivity environments, a meagre 60Hz is all that's required to deliver a relatively pleasing image; if there's nothing moving on screen apart from a mouse cursor, there's not much need to go any higher. However, evidence suggests that eye fatigue is lessened at higher refresh rates, so if you're staring at a screen all day, it could be worth upgrading to a 120Hz panel.

DLSS 3.0 = FAKE FPS?

Not content with shifting display technology via VRR, Nvidia recently debuted its DLSS 3.0 technology.

This includes the ability for the GPU to create fake frames in between real frames using some rather clever machine learning, which it calls Frame Generation. This appears to be very similar to the frame interpolation offered by most Virtual Reality ecosystems, which also generate fake frames to help smoothen out the VR image when the framerate drops. However, until we get our eyes on a new RTX 4000 series GPU, we can't say how well this technology works, but we're suspecting that DLSS 3.0 could be just as pivotal as the introduction of G-sync.

Variable Refresh Rate

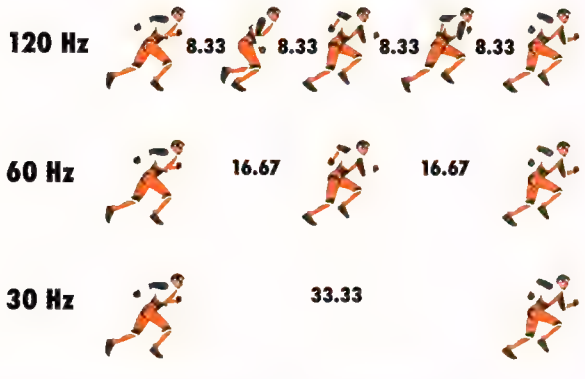
When a GPU spits out a frame that is not synchronised to a screen refresh, an issue known as screen tearing occurs, where multiple, incomplete frames can be drawn onto a single screen refresh. Nvidia was the first company to tackle this issue courtesy of its proprietary G-sync technology, which was the first Variable Refresh Rate technology to hit the mainstream. This tied every screen update to a frame outputted by the GPU. GPU only delivering 90fps? No problem, the display would lower itself to 90fps. Screen tearing disappeared, and it also led to a snappier feel to the system.

Unfortunately the G-synch ecosystem increases the price of displays, at it requires a special controller to be included in every display. However, AMD introduced its own free version of the tech called FreeSync, which did away with the need for a dedicated display controller. The HDMI organisation borrowed from FreeSync to create the industry-wide VRR specification now included in every HDMI 2.1a device. If a device supports HDMI 2.1a, it also supports VRR. However, if one device in the display chain doesn't support HDMI 2.1a – and this can even include the cable – VRR won't work at all. So if you're trying to figure out why your shiny new PS5 isn't triggering 120Hz VRR mode on your expensive OLED, first take a look at the $15 HDMI v1 cable you're trying to use.

> "When a GPU spits out a frame that is not synchronised to a screen refresh, an issue known as screen tearing occurs, where multiple, incomplete frames can be drawn onto a single screen refresh."

While HDMI 2.1 is now seen as the preferred connection choice for VRR displays, DisplayPort has been capable of the same thing since 2014, when version 1.2a launched. It's now standard for every version after 1.2a, and VRR has become so ubiquitous that the Video Electronics Standards Association (VESA) released a new set of standards for VRR displays earlier this year. Dubbed AdaptiveSync, it aims to ensure all VRR capable displays deliver an ideal experience.

With 120Hz Variable Refresh Rate displays now becoming the norm, in both PC and TV displays, gamers in particular are now treated to a faster, smoother image than ever before. But even if you're not relying on faster frames to fight your foes, a high refresh rate display could be just what the eye doctor ordered to give your eyes an easier time. ■

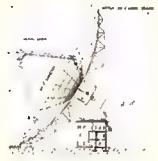


A high refresh rate not only makes gaming a more visually pleasing experience – it also delivers a competitive edge.

FEATURE

Tech that changed Australia (and the world) part 7: The Dishmaster

One of the 20th century's great moments has been credited to a few Aussie scientists in a New South Wales sheep paddock. You've seen the movie, but there's more to the story. Darren Yates writes.



A cut-away cross-section of the final 210-foot (64-metre) Parkes design (Image credit: CSIRO Radio Astronomy Image Archive).

Few moments in history impacted the world like the events of 20 July 1969, when an estimated 600 million people stopped to watch astronauts Neil Armstrong and Buzz Aldrin take 'one giant leap for mankind'. The story of how so many people saw this historic event involves not just a roll-call of Australian science luminaries, but thousands around the world, from TV engineers to renowned British engineer Barnes Wallis. The movie *The Dish* is an Aussie classic, with actor Sam Neill playing the role of station director Cliff Buxton, but the real 'dishmaster' at the Parkes Radio Telescope was one of Australia's pioneering radio-physicists (featured last month), John Bolton.

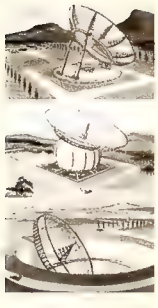
Fly me to the moon... Apollo 11 lifts off.

We're gonna need a bigger dish

Australia's war-time expertise in radar put us on the front-row grid in the race to the stars. But as the 1940s gave way to the '50s, so, too, did the CSIRO Radiophysics division's sea-side real estate for more western climes. Collaroy, on Sydney's northern beaches, gave way to Dover Heights, then Fleurs, near Badgery's Creek in Sydney's west (plus other stations dotted around the Sydney basin).

Much of early post-war solar research was achieved on tight budgets and although the CSIRO closed down its computer research in 1954 to conserve finances, hopes for bigger radioastronomy antennas for the Radiophysics division were also becoming constrained by their increasing cost.

Pioneering radio-physicist John Bolton had created something special with the 'hole-in-the-ground' dish antenna at Dover Heights in 1951 – at the time, the second-largest radio-telescope in the world – but something bigger (and a bit more manoeuvrable) was needed. A bigger 'dish' surface area was necessary to pick up the tiny radio-wave signals flying ever deeper in the galaxy. But yet again, the CSIRO's stretched finances pulled the handbrake on the plans.



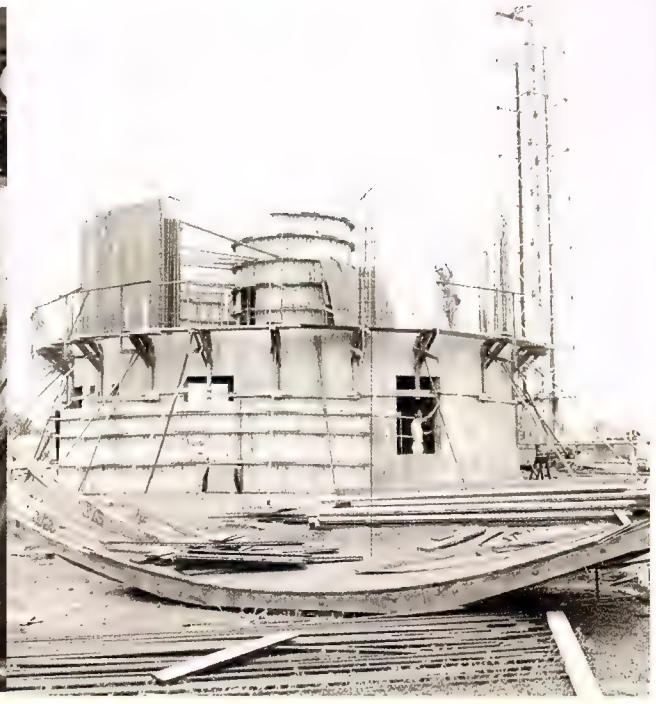
Initial artists impressions of what the Parkes 'dish' may have looked like (Image credit: CSIRO Radio Astronomy Image Archive).

Enter, the Americans and Brits

Australia was a world-leader in radioastronomy and Radiophysics division boss, Edward 'Taffy' Bowen, was keen to get his U.S. counterparts to catch the radioastronomy bug. The division reportedly even wrote the U.S. scientists a manual for how to do it, including designing a big receiving antenna. While it was originally thought the dish would be built in the U.S., some large U.S. foundations essentially decided 'let's build it in Australia, instead'. A sizeable $US500,000 in donations kicked things off, matched by the Australian Government tipping in the same.

The only problem was who would design it? Australia didn't have that kind of expertise, but the U.K. did, in the form of engineer Barnes Wallis, inventor of the bouncing-ball bombs that 'busted' the Mohne and Eder dams in German Ruhr valley during the war. His design ideas contributed to Parkes becoming the largest (and most advanced) radio-telescope in the southern hemisphere.

The completed design was developed by British firm Freeman Fox, the same team that gave Sydney Harbour it's 'coat-hanger'. Some of the original radio-telescope 'artist's impressions' look like they came from *The Jetsons*, but the final Wallis-inspired design was a marvel – 64-metres in diameter with a 'sail' area of 3,200-sq-



metres, all of it manoeuvrable to within a fraction of a degree. The German MAN (Maschinenfabrik Augsburg–Nürnberg) company won the contract to build the design, completing it in 1961.

But... why Parkes?

If you're in a big city and look up at the stars at night, you don't see anywhere near as much as if you're out in the middle of nowhere. So, that's where the CSIRO went. The 'dish' stands in a paddock about 20kms north of Parkes, which itself is roughly 350kms from the bright lights (and radio-interference) of Sydney. The Parkes region also has a flat, solid geology that meant the dish wouldn't move unless it was told to.

Tracking Mariner-2 to Venus

A new dish this big doesn't go unnoticed – and it wasn't long before the U.S. National Aeronautics and Space Administration (NASA) came calling. In early-1962, the agency wanted to know just how good the Parkes telescope was and gave the CSIRO funding to carry out detailed analysis of its capabilities. NASA was impressed enough to bring Parkes into the fold in June 1962. In August, NASA launched its first interplanetary space mission, sending off Mariner-2 to do a fly-past of the planet Venus. Parkes recorded signals sent back from the spacecraft on its journey to within 35,000kms of the planet's surface. Incredibly, by this time, Parkes had been in service for barely a year.

Co-discovering the first quasar

The dish's combination of big 'sail' area and quiet-location – not to mention the state-of-the-art electronic detectors and amplifiers under it – had Parkes also delivering important discoveries, none more so in those early days than the first quasar, dubbed '3C273'. A quasar (or 'quasi-stellar radio source') is a galaxy with an extremely bright core where the central black hole is surrounded by vast amounts of super-heated gas and emits powerful streams of radio-waves. The Parkes dish achieved this stunning discovery in conjunction with the California Institute of Technology's Palomar Observatory and is regularly regarded as changing the way we understood the universe.

We're going to the moon – can you help?

Parkes' reputation now preceded it, thanks to the work of Australian radio-physicists, including station director John Bolton, Taffy Bowen and Harry Minnett. When NASA picked up U.S. president John F. Kennedy's gauntlet of sending a man to the moon and bringing him home safely again, it was odds-on Australia would be called upon again to provide mission-critical support.

That call came in 1966, but was actually knocked back initially because of growing demands for Parkes access by local astronomers, who would have missed out as NASA's needs were met.

A chance dinner-party meeting in late-1968 between Parkes director, John Bolton, and Eb Rechtin from NASA's Jet Propulsion Lab changed the minds of both Bolton and Taffy Bowen. This was the turning point and Parkes was 'in'.

The one-line contract

In *The Dish*, during the scene where the power blackout occurs (which didn't really happen), there's a discussion about the contract between the CSIRO and NASA (which did). A meeting in early-1969 to thrash out the details was held and right at the end of the meeting, the contract was famously written in a single line – 'the Radiophysics Division would agree to support the Apollo 11 mission'. While attributed to the Cliff Buxton character in the movie, the real-life kudos goes to John Bolton. NASA agreed to pay $3,500 a day, plus $15,000 to soup up the telescope.

One small step

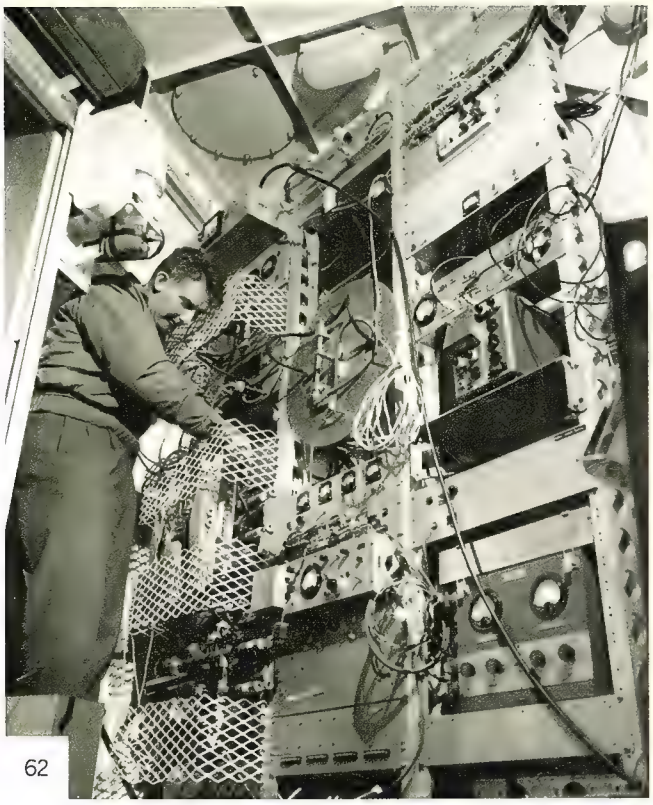
The Apollo 11 mission was a massive international

Above left: Astronomer Frank Kerr at the Parkes radio-telescope control desk, the glass dome shows the direction of the dish (Image credit: CSIRO Radio Astronomy Image Archive).
Above: Construction of the telescope tower at Parkes in October 1959 (Image credit: CSIRO Radio Astronomy Image Archive).
Below: The ribs of the dish installed via crane, the tower shows the azimuth track mechanism (Image credit: CSIRO Radio Astronomy Image Archive).

Above left: Barnes Wallis designed key parts of the Parkes Radio Telescope, plus the bouncing bomb that 'busted' the Mohne dam in Germany in 1943.
Above right: Dr. Edward Bowen, CSIRO Radiophysics chief, was the driving force in getting Parkes built (Image credit: CSIRO Radio Astronomy Image Archive).
Below: Radio-physicist John Bolton in the Parkes radio telescope's focus cabin (Image credit: CSIRO Radio Astronomy Image Archive).

undertaking and involved three stations in Australia – Parkes, the smaller 26-metre radio-telescope at Honeysuckle Creek, near Canberra in the ACT, plus the deep space instrumentation facility at Tidbinbilla, south-west of Canberra. Sadly, a fire broke out at Tidbinbilla on the day of the Apollo 11 launch and while it did lose its prime role to Honeysuckle Creek, heroic efforts to repair the damage meant Tidbinbilla was still used for telemetry to the Apollo 11 command module during the mission. Today, Tidbinbilla is now known as the Canberra Deep Space Communications Complex.

You've no doubt seen the moon-walk footage (**youtube.com/watch?v=pJbtYsooZfQ**) and sure, it's not the sharpest video you've ever seen, but the fact remains, Australia's role in the Apollo 11 mission was critical and without it, without the Parkes and Honeysuckle Creek observatories, the iconic vision of Neil Armstrong walking on the moon very likely would not exist.



We saw it first...

If you're into trivia, Australia was the first country to see the moon-walk – by several hundred milliseconds. The received raw TV signal was actually split – while the Australian Post-Master General's (PMG) Department (today, Telstra) received one feed, converted the signals into the U.S. NTSC standard and sent them around the world, the second feed was given to the ABC's Gore Hill (Sydney) studios, converted into our PAL-TV standard and sent to the local commercial TV networks. So, by sheer proximity, Australia saw the moon-walk pictures before anyone else.

... but TV almost didn't happen

According to research by CSIRO scientist John Sarkissian, sending Apollo 11 up with a TV camera on-board was not a done-deal, even just months before the launch. A quality TV camera at that time weighed plenty and given how lightweight the lunar module was, every nut and bolt counted. It took an extraordinary meeting at the NASA Manned Spacecraft Centre to determine if a camera should go up. NASA engineer Ed Fendell, part of the operations team, finished his presentation declaring he didn't think 'moon-walk TV' was needed and they shouldn't bother taking a camera on the trip. At this point, the large audience reportedly erupted and by the time they settled again, Apollo 11 was going up with a camera.

Was it Parkes or Honeysuckle Creek, or Goldstone?

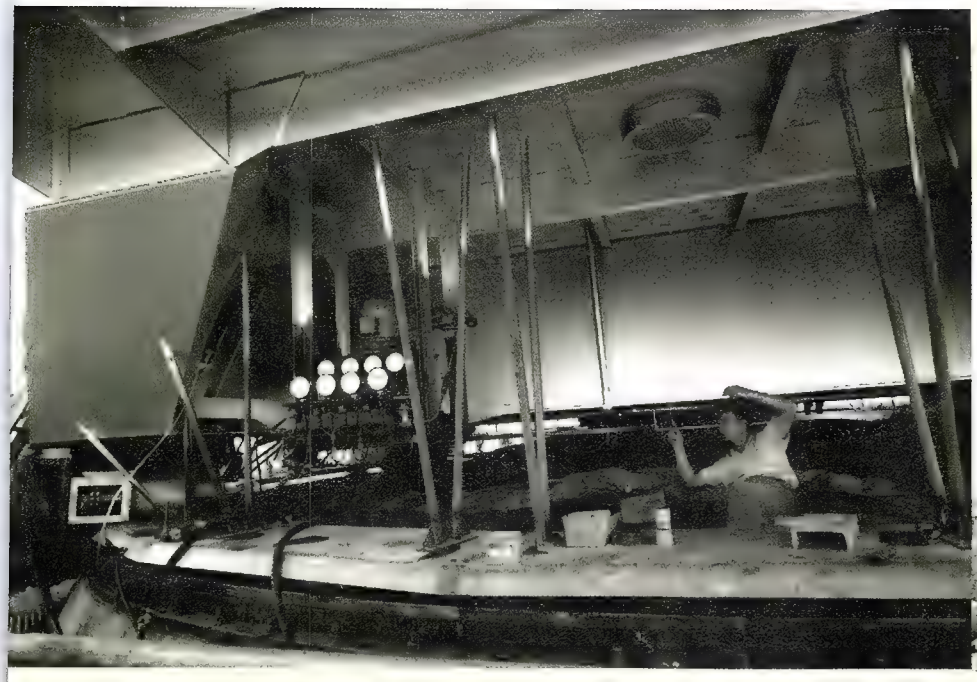
While Parkes gets the movie limelight, Australia had two of the three stations worldwide on the TV task, the second at Honeysuckle Creek. With a third dish at Goldstone in California also picking up video signals, the question is often asked which dish really had the moon-walk?

The answer in one respect is they all did. Not surprisingly, the astronauts had no interest in their planned sleep period and were keen to get 'walking'. Unfortunately for Parkes, there were two main problems at the time. First, the moon wasn't yet high enough in the sky for the dish's main axis to pick up the signal. The second was an almighty wind-storm had 'parked its backside' on the area. Winds of more than 100km/h were literally trying to knock the dish for six. But despite this, John Bolton and colleague Fox Mason performed yet another minor miracle to manually track the weak 'off-axis' TV signal from the very start with the Parkes dish pointing barely off the dirt.

But it's generally agreed the 26-metre dish of Honeysuckle Creek, because of its more easterly location, delivered the initial steps, Armstrong's famous line and the first nine minutes of the moon-walk. Parkes' bigger dish then came into 'main-axis' view and took over the remaining two hours.

So why does Parkes get all the glory-shots in the year-2000 movie and Honeysuckle Creek only an honourable mention? The Honeysuckle Creek station was decommissioned in 1981 and removed.

The Goldstone observatory



also received the video feed directly, however, technical issues meant the initial video was unusable. There are claims Goldstone was to be the prime receiver and reports are that Goldstone did provide an initial video feed for U.S. viewers, but 'Mission Control' at NASA Houston is said to have switched to Honeysuckle Creek just before Armstrong took his first step.

Australia never saw the Goldstone video – we apparently saw Honeysuckle Creek video, before switching to Parkes' output. Needless to say, with Armstrong going off-script to walk early, there was considerable pandemonium as NASA and observatories quickly co-ordinated who had the best video feed.

How they beamed the moon-walk

If you look at footage of the moon-walk, it appears quite slow and languid – part of that was a lack of gravity, but part of it was a lack of video frame-rate. The monochrome TV camera weighed as much as an old laptop, but only captured 10 frames per second (fps) at just 320 horizontal TV lines of resolution. Compare that with Australian TV's PAL standard of 625-horizontal lines at 25fps and the U.S.' NTSC standard at 525-lines at 29.97fps. So to actually view the moon-walk on Australian television, the images first had to go through a video standards-converter (done at ABC Gore Hill) to get them into PAL-form before they were then sent to TV studios around Australia.

You can read CSIRO scientist John Sarkissian's fascinating technical story of the Parkes Observatory's role in the Apollo 11 mission at **www.parkes.atnf.csiro.au/news_events/apollo11/**.

After the mission

After the dust settled, Malcolm Fraser, who was then federal minister for education and science, received a commendation message from Thomas Paine, NASA administrator, which read:

I wish to express my sincere appreciation to you and the Commonwealth Scientific and Industrial Research Organisation for making available the Parkes facility during the Apollo 11 mission. Its participation, and spectacular performance, provided the entire world with a chance to experience, with astronauts Armstrong and Aldrin, this historic event.' Amen to that.

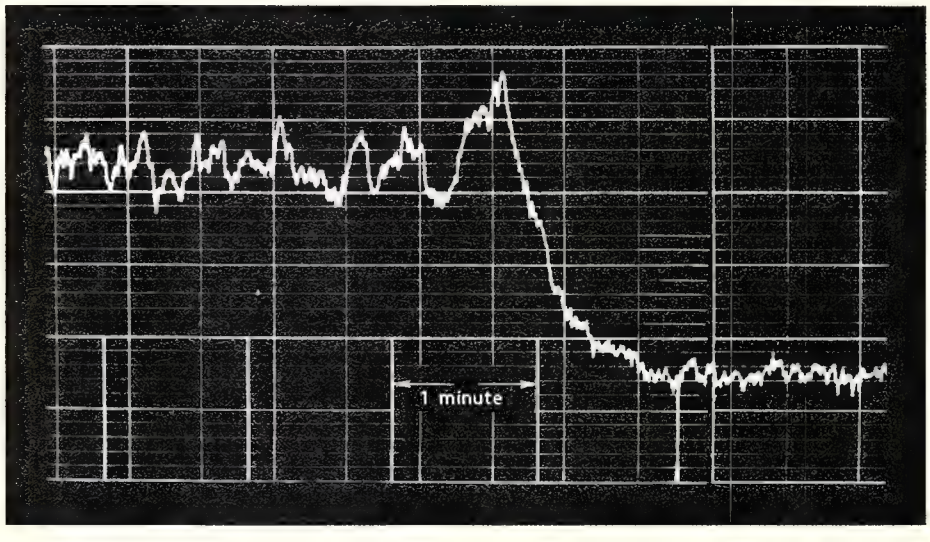
Stopping the world

Humans' landing on the moon was one of the iconic moments that those who saw it at the time will never forget. From a technology perspective, it was a triumph for the transistor and integrated circuit, but astoundingly, it was achieved with exactly zero microprocessor chips – Intel's 4004 was still a couple of years away.

While the Honeysuckle Creek station is sadly no more, the Parkes Observatory is still part of Australia's front-line astronomy network, including the grand-old 'dish' that has been scanning the solar system and beyond for more than 60 years. It'll take part in the NASA-led Artemis project to get humans back on the moon in 2024, features on the National Heritage List as a site of national importance and has received the Wiradjuri indigenous name 'Murriyang'.

Next month, in the final part of this series, we go back to 1947 to celebrate the invention of the electronic component that forever changed the world and brought us into the 'silicon age'. ■

Above left: Close-up of the azimuth track mounting the telescope rotates on (Image credit: CSIRO Radio Astronomy Image Archive).
Above right: Just your average Australian bush scene, 1963 (Image credit: CSIRO Radio Astronomy Image Archive/Ken Nash).
Below: One of the Parkes lunar occultation observations that led to 3C273 being identified as a quasar (Image credit: CSIRO Radio Astronomy Image Archive).



FEATURE

LINUX IN SPACE!

With the OS now established in astronautics, Mike Bedford looks at its future prospects.

Why do astronauts use Linux? Because you can't open Windows in space. Joking aside, the truth is that the heavens aren't full of Linux computers – but all that could be about to change.

Over the next few pages, we'll look at how Linux is becoming an important facilitator in space exploration. And that takes us from NASA's supercomputers here on Earth through to laptops in orbit on the International Space Station (ISS) and flight control computers on SpaceX's launch vehicles and spacecraft, to a single board computer empowering a helicopter flying on Mars.

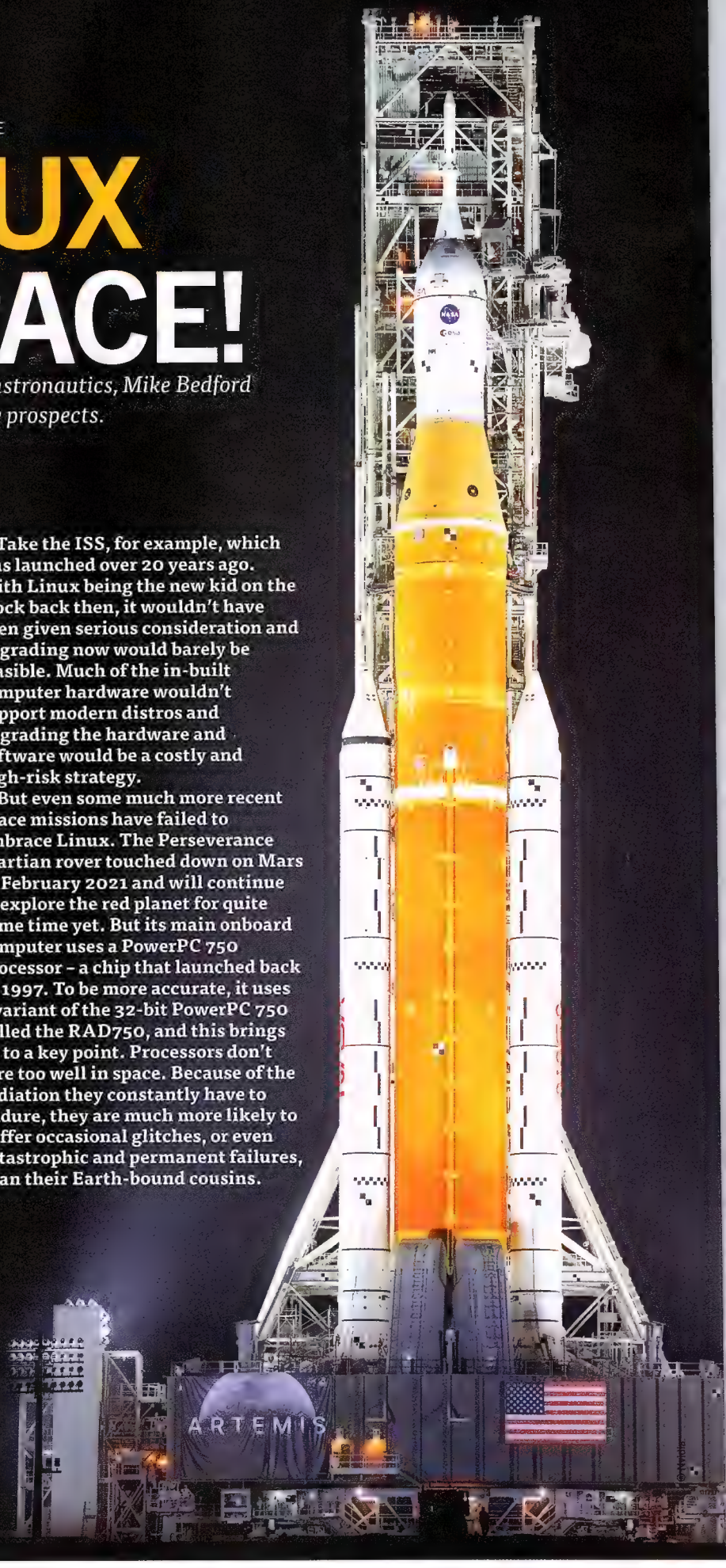
As well as looking at where and how Linux is used in astronautics, we'll also delve into why it's used. The migration of Linux into space is a recent phenomenon, though, and it's still far from universal. So, we'll also investigate what has previously held Linux back in space and, to a significant degree, continues to do so today. We'll also examine what the prospects are for it to boldly go where no operating system has gone before.

Operating beyond the Earth

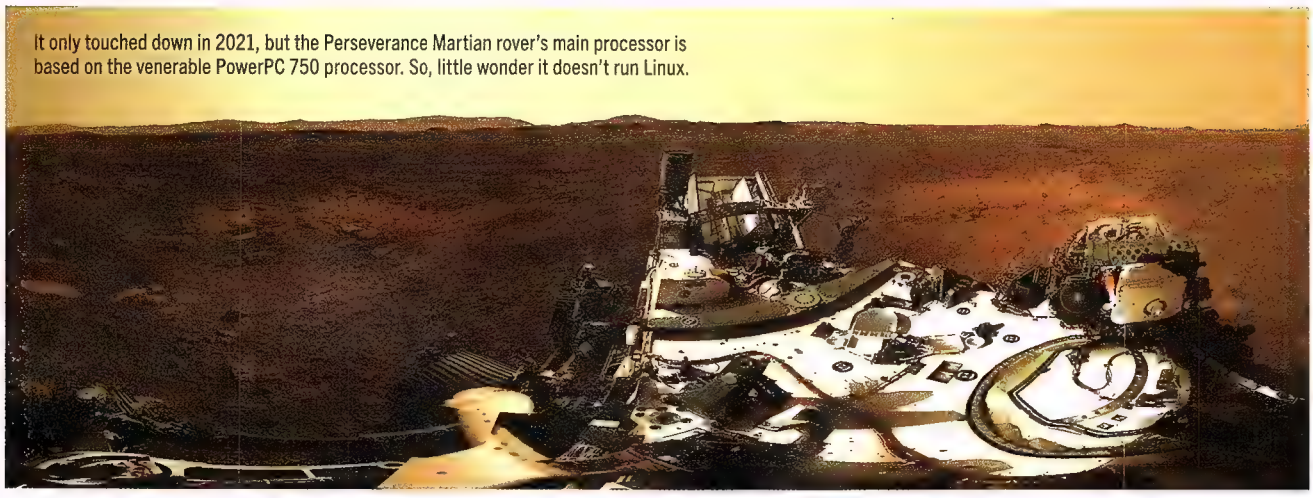
We're going to be looking at where Linux is being used in space exploration. But first, we need to consider space-based computing platforms and, in general terms, how they have influenced the operating system of choice.

Take the ISS, for example, which was launched over 20 years ago. With Linux being the new kid on the block back then, it wouldn't have been given serious consideration and upgrading now would barely be feasible. Much of the in-built computer hardware wouldn't support modern distros and upgrading the hardware and software would be a costly and high-risk strategy.

But even some much more recent space missions have failed to embrace Linux. The Perseverance Martian rover touched down on Mars in February 2021 and will continue to explore the red planet for quite some time yet. But its main onboard computer uses a PowerPC 750 processor – a chip that launched back in 1997. To be more accurate, it uses a variant of the 32-bit PowerPC 750 called the RAD750, and this brings us to a key point. Processors don't fare too well in space. Because of the radiation they constantly have to endure, they are much more likely to suffer occasional glitches, or even catastrophic and permanent failures, than their Earth-bound cousins.



NASA's Artemis program doesn't have onboard Linux machines. But on Earth, Linux is critical to pre-launch simulations.



It only touched down in 2021, but the Perseverance Martian rover's main processor is based on the venerable PowerPC 750 processor. So, little wonder it doesn't run Linux.

For this reason, processors used in space are usually radiation-hardened to withstand the rigors of life beyond Earth's atmosphere. These specialist processors aren't cheap. RAD750s cost around US$200,000 each, so we can't imagine how much they cost to develop.

The bottom line is that manufacturers bring out new radiation-hardened chips infrequently, and most chips never spawn a radiation-hardened variant. This is a further reason for the antiquity of computing hardware in space, and hence the scarcity of Linux in the heavens. But things are changing here, including on the Spaceborne supercomputer on the ISS.

In Earth orbit

Although widely-reported stories suggest that all the laptops on the ISS migrated to Linux back in 2013, the reality is more nuanced, according to Dan Duncavage, system manager of NASA's ISS Avionics and Software Office. "As you can imagine, the station contains many computational devices," he says. "Most of them are highly custom and function like avionics systems that you might find on an airliner or military aircraft." Although he didn't specifically admit it, these mission-critical systems don't employ Linux. However, beyond these central systems, we find a more varied situation.

"There's a subset of laptops and small computer boxes where Linux is used," he says. "A handful of the laptops are used by the crew as their command interface to the core avionics systems. These are based on a customised Linux kernel. The avionics interface and crew user interface software are all purpose-built for these functions, and reside on top of that Linux kernel," Duncavage explains.

"Additional laptops and IoT devices make up what's called the Station Support Computer (SSC) System. This is similar to what businesses would call a mission-critical IT infrastructure. It supports everything from email to highly custom experiment interfaces and all of the crew's medical monitoring – and it runs the unique space exercise equipment," says Duncavage. "The majority of the SSC laptops are Windows 10 clients; the IoT devices are built on Debian Linux. The remaining laptops are distributed to experiment-specific applications and international partners. Some of these are Windows and some are Linux of various distributions," he says.

Onboard the ISS are Honey, Queen, and Bumble. Collectively, these free-flying robots form the Astrobee system. Their job is to help astronauts reduce the time they spend on routine duties, leaving them to focus more on the things that only humans can do. According to NASA, the robots are designed to complete tasks such as taking inventory, documenting experiments conducted by astronauts with their built-in cameras, or working together to move cargo throughout the station. In addition, the system serves

GEARING UP THE RASPBERRY PI FOR SPACE

An initiative of the European Space Agency in collaboration with The Raspberry Pi Foundation, Astro Pi is providing teams of young coders with the opportunity to see their applications running aboard the International Space Station, Python, and the Linux Operating system.

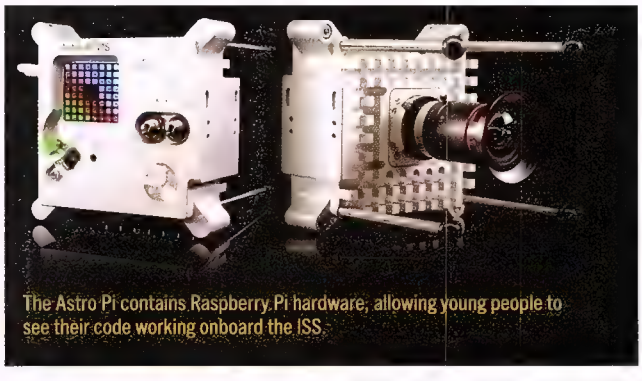
The Astro Pi platform comprises an RPi 4, a sensor HAT, and an HQ Camera. But, as you can see from the photograph, it doesn't look like any previous Raspberry Pi-based platform.

Stringent testing was required before the Astro Pi was allowed onboard the ISS. First, the machine had to be capable of withstanding the huge vibrations that occur at lift-off. To ensure the safety of the astronauts who will use them, the surface temperature of the case couldn't exceed 45°C.

It also had to have no sharp edges and it had to be proven that it wouldn't interfere with other equipment on the ISS, or that such equipment would interfere with the Astro Pi.

Two of the latest generation of Astro Pis were taken to the ISS in December 2021, to replace the previous Astro Pis that had spent six years in orbit.

Following a test period by astronauts in space, they are now ready to run student programs. Entries were open to teams of young people, aged 19 or under, from ESA member states, plus Slovenia, Canada, Lithuania, Latvia, and Malta. Winning entries were deployed in May, with the 2022-23 challenges launched in September.



The Astro Pi contains Raspberry Pi hardware, allowing young people to see their code working onboard the ISS.

© NASA, ESA/NASA, NASA/JPL

as a research platform that can be outfitted and programmed to carry out experiments in microgravity – helping NASA learn more about how robotics can benefit astronauts in space. And its control computers run Linux, more specifically two of its three ARM-based computers run Ubuntu/ROS, while the third is equipped with Android 7.1.

So we've seen Linux-based laptops and flying robots in Earth's orbit, but a more powerful Linux machine was taken to the ISS in 2017 for a year-long mission. Called the Spaceborne Computer, it has been described as a supercomputer and its purpose was to research alternatives to the usual radiation-hardening approach for protecting computers from the hazards of radiation exposure. This, it's suggested, will pave the way to using more up-to-date and higher performance processors than are currently used, as would be required for future long-term manned missions, such as to Mars.

The Spaceborne Computer is a commercially available supercomputer, designed and produced by Hewlett Packard Enterprise (HPE). It includes HPE Apollo 40-class systems with a high-speed interconnect, running an open-source Linux operating system. According to HPE, the Spaceborne Computer contains compute nodes of the same class as Pleiades, one of NASA's premier supercomputers.

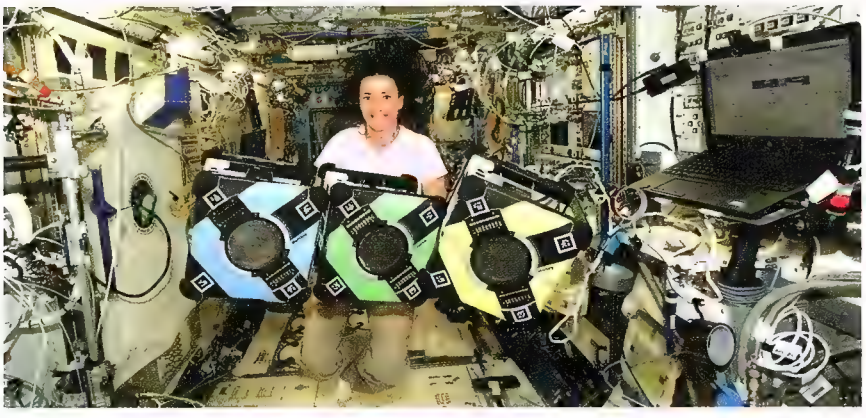
SpaceX's flight control computers aboard craft such as this Crew Dragon operate under Linux, in a marked departure from NASA's usual approach.

As an alternative to using radiation-hardened processors, a software solution was developed to mitigate the negative impacts of radiation on reliability. During high-radiation events, the electrical power consumption and, therefore, the operating speed of the computer system was lowered, with the aim of determining if such systems can still operate. The conclusion was favorable.

During its demonstration mission, the Spaceborne Computer performed more than one trillion calculations per second (one teraflop) for 207 days without requiring a reset.

While we've not yet seen Linux employed in NASA's mission-critical jobs, that situation is changing and the ISS is a beneficiary. Until it was retired in 2011, the Space Shuttle took astronauts and supplies to the ISS, alongside the Russian Soyuz and a few other launch vehicles. For a while, the USA had to hitch a ride to the ISS on the Russian launch vehicle, but then, in 2012, the forces of capitalism came into play. Space was no longer the sole domain of government-owned space agencies. Now, the ISS is also supplied by launches by SpaceX and Northrop Grumman Space Systems. And the SpaceX Dragon spacecraft and its Falcon launch vehicle are especially interesting.

Where NASA leads, SpaceX follows, you might think. But that isn't the case with its choice of operating systems. For while NASA's forthcoming SLS launch vehicle uses a proprietary Boeing operating system in its flight



These floating Astrobee System robots run Linux and assist the ISS crew with basic tasks.

SUPERCOMPUTING AND SPACE EXPLORATIONE

NASA is intent on returning astronauts to the Moon for the first time since Apollo 17 in 1972. Called the Artemis program, it is based on the Orion spacecraft that will be launched on the new Space Launch System (SLS) rocket.

Given NASA's apparent reluctance to use Linux for mission-critical applications, it probably comes as no surprise that Linux doesn't form a part of either Orion or SLS. That doesn't mean that the success of Artemis won't depend on Linux though.

Underpinning the design and verification of all NASA's spacecraft is simulation, and Artemis is no exception. It's not surprising that these simulations are hugely processor-intensive, so some serious computing muscle was called for.

Simulations of the landing process, for example, are being carried out at NASA's AMES Research Center in California on a supercomputer called Aitken. In November 2021, when it boasted 242,688 cores, it was the world's 49th fastest computer, but it's been expanded since.

Needless to say, the operating system has powered all the world's 500 fastest supercomputers since 2017.

If you want to know why Linux is the undisputed king of supercomputing, with commercial top-end operating systems being licensed per core, if you've got a quarter of a million cores, FOSS is surely the way to go. Such financial considerations are just the tip of the iceberg.

© NASA, NASA/Shane Kimbrough.

control computer, and the Orion crew exploration vehicle uses a real-time operating system called Integrity-178B from Green Hills Software, it appears that SpaceX is firmly in the Linux camp. But this is no ordinary Linux, and certainly not any distro you might choose for your PC.

Although SpaceX hasn't confirmed it, the consensus is that the Falcon 9 launch vehicle uses a stripped-down version of Linux running on x86 processors, and the flight control software was written in C++.

Seen here undergoing a final inspection prior to launch, the Ingenuity drone is now operating on the red planet, thanks to its Linux-based computer.

Further afield

We'd love to be able to tell you that a Linux-based computer is on board the Pioneer 10 and 11 spacecraft, which have now left the Solar System, heading for the stars. But the first of these probes was launched just four months after the first microprocessor, Intel's 4-bit 4004, landed on the market. The Pioneers carried computers made from individual logic chips that probably didn't even have an operating system. However, Linux can be found beyond the confines of the Earth, 278 million kilometres beyond it, in fact – and it took over six months to get there.

The Jet Propulsion Laboratory in California is responsible for NASA's missions to Mars and beyond. Tim Canham, senior flight software engineer at JPL, explains the factors behind the increased use of Linux in space. First the success stories. "Linux has had two prominent uses here at JPL," he says. "The Mars Ingenuity helicopter and the Perseverance Rover EDL camera system. Both systems were considered technology demonstrations and weren't critical to the survival of the Rover, but Linux has performed well in both cases."

Given that Linux is excluded from some space projects because of the antiquity of the computing hardware, one reason for its inclusion on Ingenuity makes a refreshing change. The Martian atmosphere is more than 100 times thinner than Earth's and this places huge demands on the design of an aircraft intended to fly on the planet. As well as larger-than-usual rotors, keeping the weight down to a minimum was critical, and this brings us to the computing hardware.

An ARM-based Qualcomm Snapdragon 801-based computer system was chosen to meet these strict requirements. Linux was selected because the VxWorks operating system that would normally be used by NASA in such applications wasn't available for the Snapdragon chip.

So why are these applications the exception rather than the rule? Apart from the legacy nature of the computing hardware often used in astronautics, what else has held back the application of Linux? Canham suggests a few reasons, including a concern about real-time performance. "Flight software typically has hard software deadlines that have to be met to guarantee the survival of the spacecraft. If the operating system can't make guarantees that those deadlines can be met, it can't be used.

"Linux isn't primarily designed as a real-time operating system. It has real-time patches to the mainline kernel to improve the performance, but applying it to modified kernels provided by board vendors has been problematic. The fairness algorithm and underlying I/O make it hard to guarantee the timing."

His second reason might cause a few hackles to be raised. "Fairly or not, there's a perception that since Linux is based on a lot of open-source contributions, it's difficult to know or reasonably assess the quality of the code that comprises the kernel, drivers, or other apps running in the distribution."

But things are changing, as Canham explains. "The role of Linux is evolving and different organisations have different risk postures related to usage, but for NASA, Linux can find a niche in areas where it has advantages: data processing and operation of fight hardware in non-critical contexts. Linux brings huge open-source advantages that can speed development and take advantage of software already available in the community. I also think there's a chance to deploy Linux in a compute environment where hypervisors can separate the real-time domain from the processing domain."

So while Linux hasn't yet turned space exploration on its head, changes are taking place. And you can take some comfort in the fact that Ingenuity, the first aircraft ever to fly above the surface of an alien world, is a Linux-powered miracle of astronautical engineering. ■

INTRODUCING CUBESATS

Space exploration might have evolved to use commercial service providers such as SpaceX, but further democratisation of space research is just a pipe dream, you might think. But you'd be wrong.

CubeSats are tiny satellites, measuring just 100mm across and weighing no more than 1.33kg. They can cost as little as $64,000 to build and because they can be launched from the ISS or as a secondary payload alongside more mainstream satellites, they can be launched for not a lot more. As such, they have formed the basis of student projects, often with funding from bodies like the ESA, and have even been built by groups of enthusiasts, for example, amateur radio societies.

Although Linux isn't universal in CubeSats, given that the open source philosophy is key to much of the CubeSat community, it's no surprise that Linux is a common choice, alongside the likes of FreeRTOS.

The open-source approach goes well beyond the operating system, and it isn't even restricted to the software. Open hardware processor boards are common. You can find designs for components such as thrusters, and there have even been complete open-source satellites, including a design by the Libre Space Foundation.

What's more, there are networks of open source satellite ground stations and, if you have access to a 3D printer you can even build your own ground station for just a few hundred dollars.

© NASA/JPL/Caltech

Group test

Reviewed by KENNY HEMPHILL

ON TEST...
- BusyCal 3.8.3 (Mac version 2022.3.1)
- Calendars 5.2.22
- Fantastical 3.3.6
- Google Calendar
- Moleskine Timepage 3.7.4 (Mac version 1.0.6)
- Week Calendar 15.3.1 (Mac version 2.1)

THE BEST CALENDAR APPS FOR MAC & iOS

We pit the best calendar apps for Mac and Apple devices against each other to find out which is best.

Apple's Calendar app for Mac, iOS, iPadOS and watchOS has plenty going for it. For one thing, it's deeply integrated with Apple's other apps and the operating systems themselves. And for some people, it may be all they need from a calendar app. However, for those of us who want more – good natural-language entry, for example – it doesn't offer enough. But, there are plenty of excellent alternatives, from Google's free, but powerful app, to Moleskine's stunning Timepage.

In testing these apps, our main focus was that they offered enough over and above the features in Apple's app to make them worth the cost. We also wanted to know how well they sync across platforms and how easy they are to use, particularly when it comes to adding appointments and other entries.

Additional features such as the ability to manage tasks and support for Shortcuts are the icing that sweetened the deal for some apps compared with others. And if a paid-for app offers a free trial, so much the better.

HOW WE TESTED

Our testing process was simple. We added the same appointments and events to each of the six apps in this round-up using natural language, such as: "Dinner with Carol at 8pm on Wednesday." For those apps that needed it, we also manually entered dates and times. We then tested how quickly the appointments and events we created were synchronised with our other devices. If an app supports Shortcuts, we also checked what pre-made actions are available. Finally, we looked at presentation and how easy it is to see appointments and events in different views on each app.

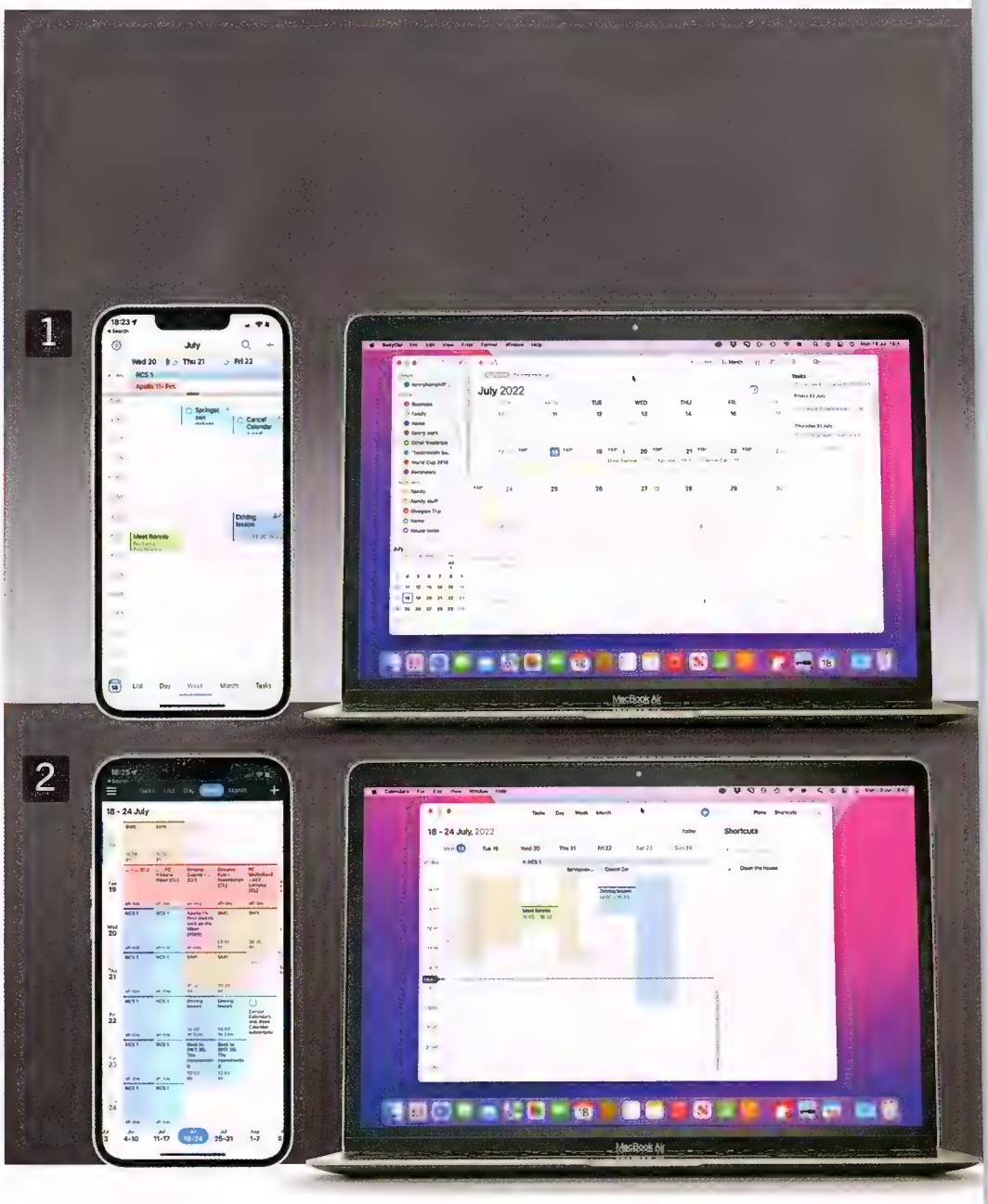
THINGS TO CONSIDER...

1 CAN YOU JOIN MEETINGS IN THE APP?
Online meeting apps are now a necessity for many of us and some calendar apps make it simple to join meetings directly from the calendar appointment.

2 SUPPORT FOR NON-APPLE PLATFORMS
Apple's Calendar is only one of several calendar services you might use. Others include Microsoft Outlook and WebDAV.

3 TRAVEL TIME
Some calendar apps detail how long it will take to travel to an appointment, and can alert you when it's time to leave.

4 MAC SUPPORT
All the apps here have iOS and iPadOS versions, but if you use your Mac to add calendar entries you may want a native Mac app, too. All the apps on test have a Mac app, with the exception of Google Calendar.



BUSYCAL

■ macOS $48.99/year, iOS $10.99 | busyapp.com

1 BusyCal's main attractions are its cusomisation options and the ability to add filters to search queries and then save those queries to use in the future. BusyCal supports natural-language input, a boon if you prefer typing an appointment rather than selecting the date and time from menus. BusyCal also displays the weather forecast, and shows the phases of the moon. Like all the apps here, BusyCal works with the main calendar services: iCloud, Google, Office 365 and WebDAV. And it can pull in reminders from the Reminders app (though it doesn't work with the new Reminders introduced in iOS 13 and macOS Catalina).

Customisation includes choosing how many days are in a week, and setting font sizes, colours and time formats. Tasks can be integrated in the calendar or viewed in their own task list.

BusyCal is available from both the developer's website and from the Mac App Store.

Natural-language input, lots of customisation and can save searches, though there remain some compatibility issues.

★★★★☆

CALENDARS

■ $24.99/year | readdle.com

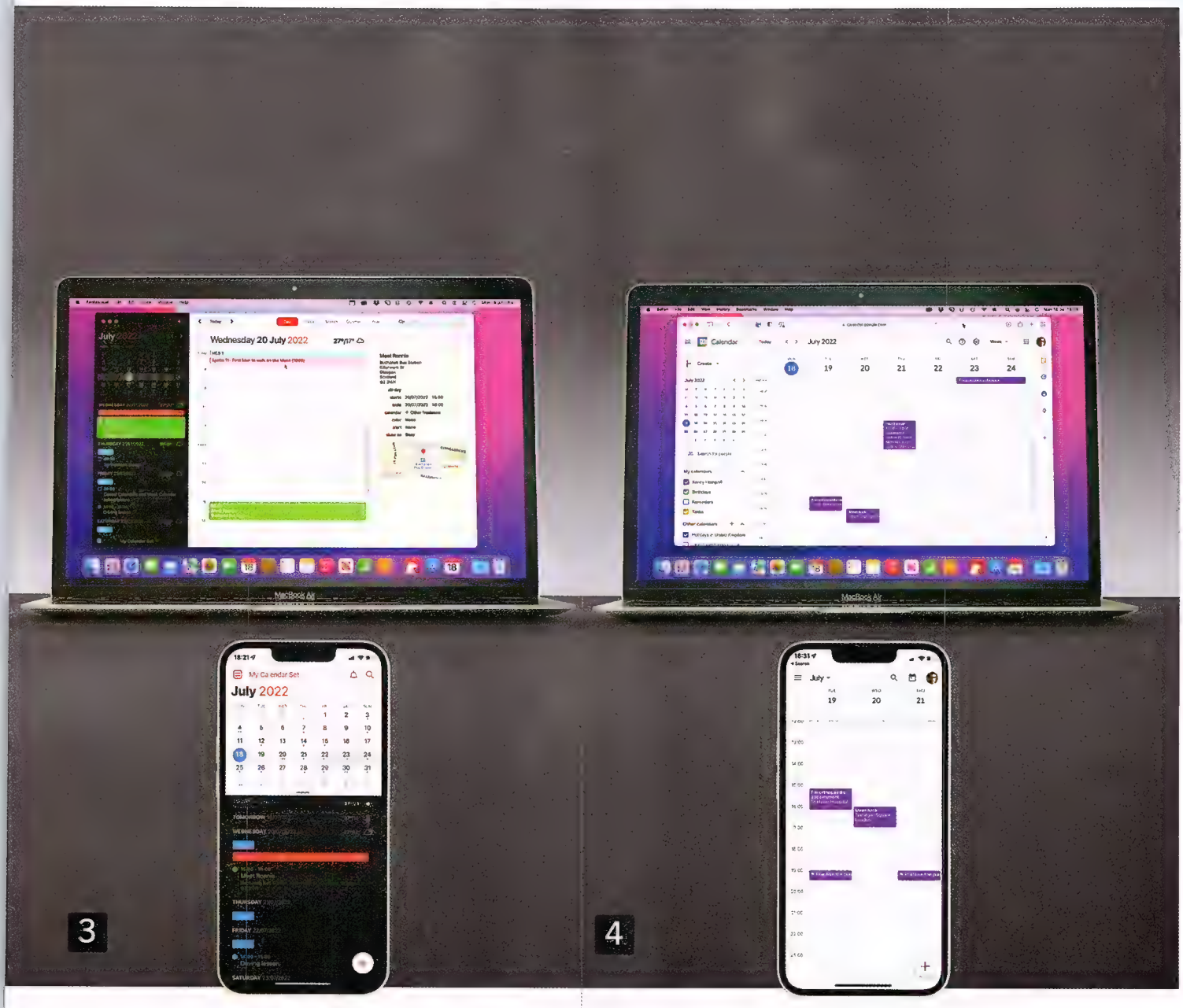
2 Readdle's Calendars app has been available on iOS and iPadOS for years, and it's now on the Mac. There's a free version, which limits you to one calendar, and a paid-for Pro version that unlocks more features. Subscribe to use it on Mac, iPhone, iPad and Watch.

Calendars combines the features you'd expect from a calendar app with some of those you'd find in a task manager, including the ability to pull in tasks from Apple's Reminders. However, it differs from the other apps in that it's geared towards helping you consolidate positive habits. So, in the setup, you're asked to choose a regular time each day for the tasks that will help achieve that.

Calendars enables you to drag and drop tasks from the task list onto a calendar to schedule them. You can create shortcuts for regular tasks, while Calendars' natural language support is excellent.

Natural-language support, good task-management features and lots of shortcuts actions.

★★★★☆



3

FANTASTICAL

■ $65.99/year (includes Cardhop) | flexibits.com

Fantastical is one of the oldest and most popular calendar apps on iOS and for very good reason. Its natural-language input is second to none, so it's easy to add events and appointments. It's available across all Apple platforms, making it a strong choice if you have an Apple Watch, iPhone, Mac or iPad.

You can use some app features for free, but if you want access to everything, you'll need to pay for the premium subscription. This unlocks all features on all devices, and also covers Fantastical's contacts app, Cardhop. For example, the free version enables you to see up to three days of weather forecasts, while the paid-for version allows ten.

You can use the app as a task manager, and import tasks from Reminders. And you can create templates for events, tasks and more. Calendars can be grouped into sets, and you can make sets activate automatically depending on your location.

Natural-language input is excellent, ability to create templates plus good time zone support and a stunning interface.

★★★☆☆

4

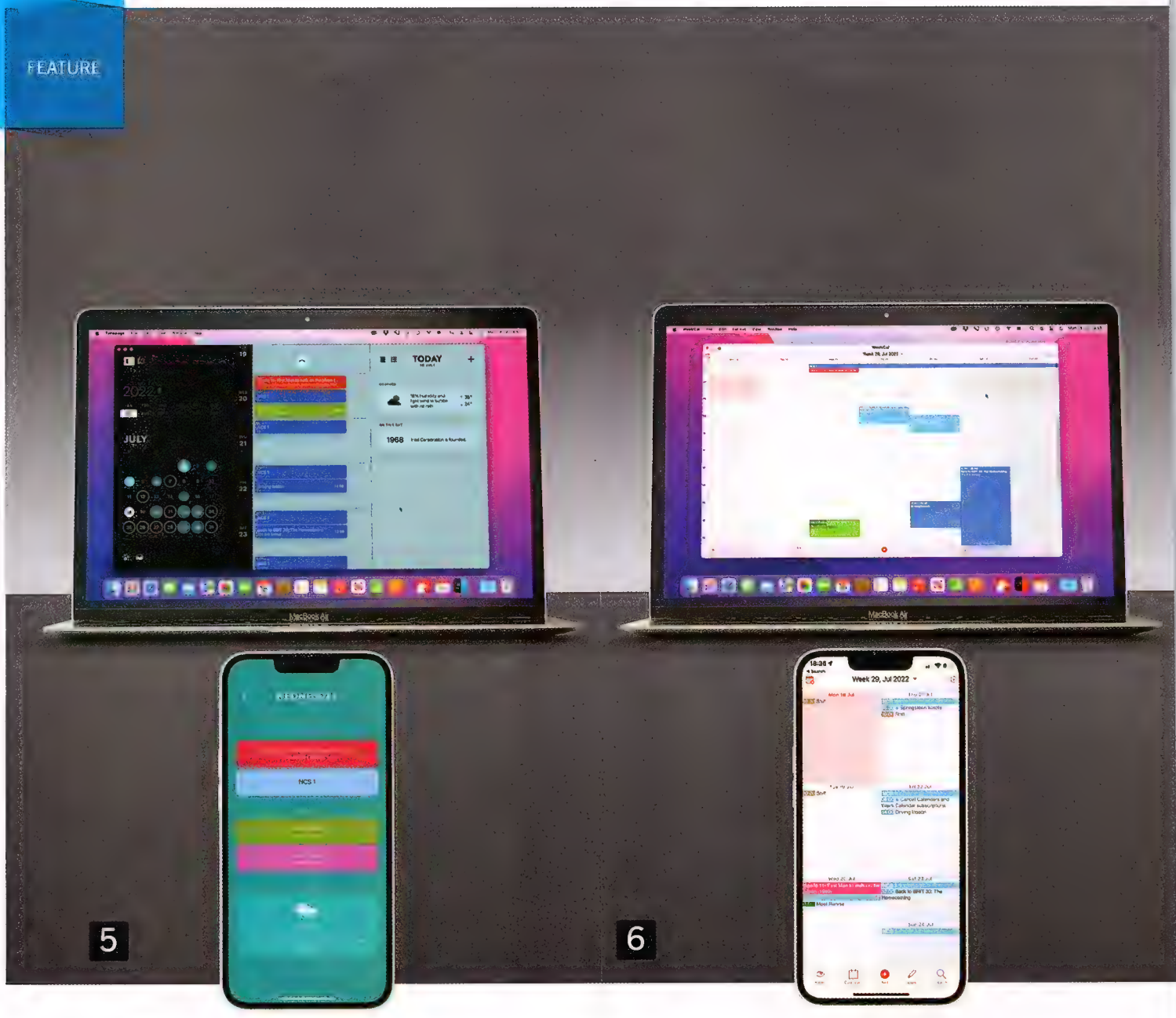
GOOGLE CALENDAR

■ Free for individuals | google.com

If you're looking for an alternative to Apple's Calendar app that provides more than the bare minimum for free, or you're invested in Google's other services, Google Calendar is a good choice. As well as using it on iPhone or iPad to manage Google Calendar events, you can add your iCloud calendar account, though the process is far from simple and needs to be done in a web browser. If you want to use Google Calendar on your Mac, you'll also need to use a web browser. On the plus side, the interface looks great, it's integrated with Gmail and other Google services, and you can join online meetings from within the app. There are also templates for creating recurring events, such as practicing an instrument; tell the app you want to practice for an hour a day and it will find time in your schedule. There's no natural-language input support, but the '+' for adding an event is clearly visible on your iPhone.

Free for most users, excellent interface on iOS, template automation though no natural-language input.

★★★★☆



MOLESKINE TIMEPAGE

■ $22.99/year | moleskinestudio.com

5 If this round-up was based on looks alone, Moleskine's Timepage would easily win hands down. Like all of Moleskine's apps, it looks really stunning. And the good news is that this calendar app is now available on the Mac, as well as iOS.

The additional screen space on the Mac, compared with the iPhone, enables you to see the month view, timeline, and Today card next to each other. The Today card is nice and neat too, putting your appointments, tasks, the weather forecast and 'On this Day' info in the same window.

When it comes to adding appointments and events, then Timepage lags behind some of the other apps here because it doesn't support natural-language input. However, it has some good features to take away some of that pain. For example, on iPhone, you can tap and hold '+' and drop it on a day to add an event. The app also remembers what you've typed previously and will use that to offer suggestions at the top of the keyboard.

Lovely interface and it's easy to add entries. We like the weather forecast though there's no natural-language input.

★★★★☆

WEEK CALENDAR

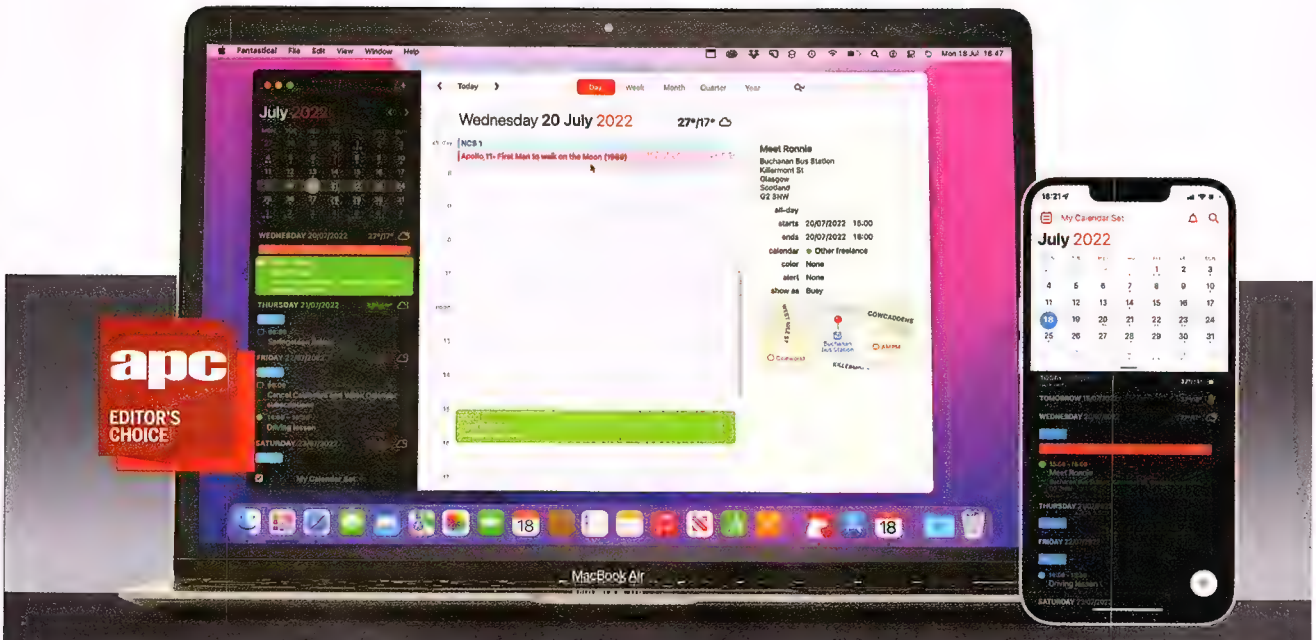
■ $29.49/year or $63.99/year | weekcal.com

6 There's a lot to like about Week Calendar on both Mac and iOS (it works on Apple Watch too), including support from Reminders, the ability to create templates for recurring events and an hourly weather forecast in the Today view. It also makes it simple to find and subscribe to public calendars from within the app. And it has support for both Mac and iOS Widgets.

However, the natural-language input support, and weather forecasts cost extra on top of the annual subscription. The interface on the Mac version was also poorly laid out – the '+' button for adding a new event, for example, is tiny and stuck at the bottom of the screen. On the plus side, the Day view on both iOS and Mac has three options, so you can choose how to list appointments. And the Mini Month view provides an excellent overview of everything happening in a given month.

Handy templates for recurring events and a convenient hourly weather forecast option. No natural-language input and interface is cramped.

★★★★☆



THE WINNER
Fantastical

Its stunning interface and natural-language input make Fantastical a joy to use.

Each of the apps in our round-up has something to commend it and you won't go far wrong if you choose any of them. The fact that Google Calendar is free and hooks into the rest of its services is a big plus, and BusyCal's natural-language support and customisation options make it worth a look. Readdle Calendars' focus on positive habits could be helpful for some, too. Moleskine's Timepage is lovely and a pleasure to use. Its Today card is particularly good. And Week Calendar's Mini Month view is a good way to get an overview of a month's worth of appointments. However, all of these apps had negatives, whether that was a lack of support for natural-language input, a cramped interface, or missing features. Only Fantastical came through our tests unscathed. It looks terrific on all versions, and the intelligent use of gestures in the iOS and iPadOS versions make it fun to use. Little touches, like the animated alarm bell, add to that. It's a worthy winner.

HOW DO THEY COMPARE?

Specs	BusyCal	Calendars	Fantastical	Google Calendar	Moleskine Timepage	Week Calendar
Website	busymac.com	readdle.com	flexibits.com	google.com	moleskinestudio.com	weekcal.com
Base Price	Free	Free	Free	Free	Free	Free
Full price (including iOS versions)	Mac: $48.99/year iOS: $10.99/year	$24.99/year	$65.99/year	Free	$22.99/year	$29.49/year ($63.99/ year including weather features
Features						
Calendar services supported	iCloud, Google, Exchange, Office 365, Yahoo, Fastmail, Kerio, Synology, Nextcloud	Google, iCloud, Outlook	iCloud, Google, Exchange, Office 365, Outlook, Yahoo!	Google, iCloud	iCloud, Exchange, Office 365, Google, Todoist, Yahoo!	Zoom, Google Meet
Natural language input	Yes	Yes	Yes	No	No	No
Join meetings?	Google Meets, Zoom, Webex, GoTo Meeting	Zoom, Meet, Go To Meeting	Microsoft Teams, Google Meet, Zoom, and Webex	Google Meet	FaceTime, Zoom, Microsoft Teams, Skype	iCloud, Google, Yahoo!, Outlook, Exchange ActiveSync, CalDAV
Travel time?	Yes	No	Yes	No	Yes	Yes
Shortcuts actions	None	Three	Three	Three	Three	Three

Note: The final verdict scores reflect the overall opinion of a product and are not necessarily an average of the criteria listed in the table.

Why you must always...

UPDATE YOUR DRIVERS

Don't let old and corrupt drivers slow and crash your PC, or stop vital features working properly. Robert Irvine explains how to keep all your device drivers updated – for free.

WHAT YOU CAN DO

- Install optional driver updates that Windows Update ignores
- Download the latest drivers from device manufacturers
- Update all your drivers with the best available versions
- Manually add a driver to the Windows driver store
- Avoid driver updaters that install junk and malware
- Remove old drivers for devices you no longer use
- Undo driver updates that cause problems on your PC

Drivers are an essential element of your PC. Without them none of your internal or external devices would work. But as with most 'under the bonnet' technology – from cars to computers – you don't usually need to worry about them until a vital feature stops working or your system becomes slower or crashes.

This happens more frequently than you might think. Microsoft says that 70 per cent of blue screen of death errors are caused by third-party driver code (see **www.snipca.com/42992**).

Ensuring your drivers are up to date and functioning properly will keep your system running smoothly, though it's not a task you need to perform every week like a virus scan. Windows 10 and 11 generally do a good job of automatically updating drivers in the background. However, as we explain in this feature, Windows doesn't always install the best versions of drivers for all your devices, as soon as they're available, so it's useful to know how to update your drivers manually.

We reveal the easiest and safest free methods for keeping your drivers current, using options built into Windows, and by downloading the latest versions from the manufacturers.

We also recommend the few third-party tools you can trust to check for and install driver updates, and name and shame the dubious programs you should definitely avoid.

YOUR DRIVER QUESTIONS ANSWERED

What are drivers and why are they important?

Every component of your PC's hardware, whether internal such as your motherboard and graphics card, or external like your mouse and keyboard, requires a small piece of software called a driver. This tells Windows exactly what that component is and does, and enables the devices to interact with each other.

For example, your printer's driver allows your operating system to identify your printer, convert data into a printable format and send it to the device to be printed using settings you've specified. Without a driver, your PC can't properly communicate with a device, rendering it useless.

How do I install device drivers?

There was a time when you needed to install device drivers manually, from a floppy disk or CD-ROM that came in the box with the device. Nowadays, with a few exceptions such as printers and some scanners, Windows does the hard work for you.

As soon as you connect a device to your PC, Windows searches its huge database of drivers for the best one, then downloads and installs it, displaying a 'Your device is ready to use' message when this is done (see screenshot below). This system is known as 'Plug and Play' (PnP) and, though there's a common misconception that no drivers are involved, it simply means Windows automatically identifies the device and loads the latest available drivers with "minimal user intervention" – see Microsoft's 'Introduction to Plug and Play' page at **www.snipca.com/42959**.

However, Windows doesn't always get it right and may fail to find a driver – especially for devices from more obscure manufacturers – or install one that causes problems rather than fixing them.

Why do I need to update my drivers?

An outdated driver may still let your PC communicate with a device, but it can also cause performance problems. For example, if the driver for your graphics card isn't up to date, you may experience a pixelated or flickering picture, or colours that are slightly off, when watching a video or playing a game.

Likewise, an outdated audio driver may distort or entirely silence your system's sound, while having an incorrect or corrupt driver for your network adapter can prevent you from connecting to Wi-Fi. If your motherboard's chipset drivers aren't the latest versions, your PC may become frustratingly slow and keep crashing.

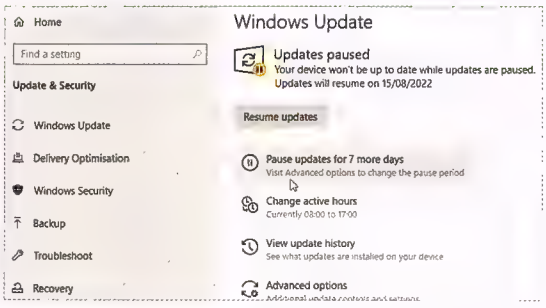
Failing to update your drivers can mean missing out on new device features, bug fixes and performance improvements. More seriously, it can leave your computer susceptible to hackers and malware, because an old driver may contain security vulnerabilities that attackers can exploit.

When should I update my drivers?

Most drivers are updated automatically through Windows Update, so you don't need to worry about installing the latest versions. However, this doesn't always happen, especially on older computers, or you may have 'paused' updates to stop them being installed (see screenshot above right).

If you've started experiencing problems with your PC, updating your drivers can help solve them – even if you're unsure which device is responsible. It can also prevent hardware-compatibility problems and keep your system running smoothly and securely.

Furthermore, when you buy a new, second-hand or refurbished PC, or reinstall Windows on your current PC, it's essential you ensure you're using the correct drivers. These may not necessarily be the latest versions, but the best drivers available for each PC component. For example, the drivers provided for graphics cards by manufacturers such as Nvidia and AMD will offer far superior performance and features to any generic drivers selected by Windows.



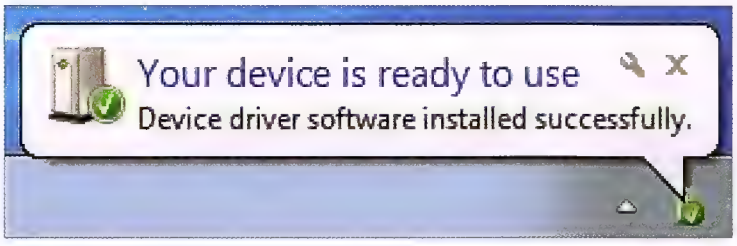
If you've paused Windows Update, your drivers won't be updated automatically.

Are there any risks to updating drivers?

The biggest danger is installing drivers you find online from unofficial sources, which may not be 'digitally signed' (ie, verified by Microsoft) and may contain malware or cause performance problems. Windows should detect and block such drivers, but there are ways to bypass the restriction.

Occasionally, drivers released by manufacturers contain security flaws or cause compatibility issues, but they're still much safer than those from third-party sites and are usually swiftly patched to fix reported bugs. For example, in May, Nvidia released an update that fixed 10 vulnerabilities in its GPU drivers, after they were discovered by cyber-security company Cisco Talos (**www.snipca.com/42960**).

You should also be wary of software that claims to scan your system for outdated drivers and install new ones. On page 77, we've picked three driver updaters you can trust.



Windows automatically finds and installs the best drivers available for 'Plug and Play' devices.

HOW TO UPDATE YOUR DRIVERS

Install drivers through Windows Update

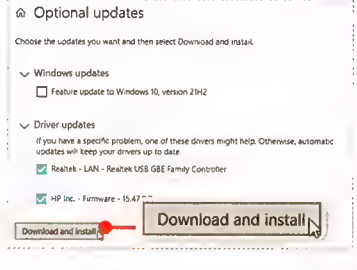
The latest updates for drivers can take a while to appear on Windows Update, but it's still the simplest and safest way to download and install them. Not only are you getting updates through a trusted source, but you can be sure the drivers will be compatible with your devices.

When manufacturers submit drivers to Microsoft to be digitally signed, they mark them as either 'automatic' or 'optional'. Automatic driver updates are important for security and performance reasons and are installed automatically through Windows Update, while optional ones usually fix minor bugs or add new features.

To check for optional updates in Windows 10, open the Settings app (press the Windows key-I), click 'Update & Security' and select Windows Update. Click 'View optional updates' and open the 'Driver updates' list. In Windows 11, click Windows Update on the left-hand side of the Settings app, choose 'Advanced options' then 'Optional updates' and select 'Driver updates'. Tick the boxes next to all the driver updates you want to install and click 'Download and install' (see screenshot below).

Before you do so, it's worth searching for the driver's version number online to check if there are any known problems with the update. If you can't see a 'View optional updates' option, then none are currently available through Windows Update, but that doesn't mean you can't install them using other methods.

If you want to update all your drivers manually or by using a driver-updater tool (see opposite page), you can stop Windows Update installing automatic driver updates. Right-click the Start button in Windows 10 or 11 and choose System then 'Advanced system settings'. When the System Properties box opens, select the Hardware tab and click Device Installation Settings. Choose 'No' under 'Do you want to automatically download manufacturers' apps...?' and click Save Changes.


Optional updates
Choose the updates you want and then select Download and install.
Windows updates
Feature update to Windows 10, version 21H2
Driver updates
If you have a specific problem, one of these drivers might help. Otherwise, automatic updates will keep your drivers up to date
Realtek - LAN - Realtek USB GBE Family Controller
Download and install

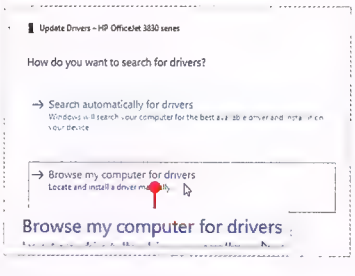
Manually install optional driver updates through Windows Update.

Update drivers via Device Manager

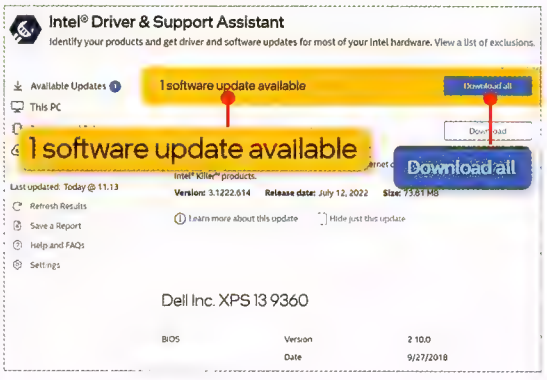
If a device driver is not yet available through Windows Update, you can download it from the manufacturer's official support website, and install it through Device Manager. Search for the model of the device in the drivers section of the site to find and download the latest driver update. Some drivers are provided as EXE files, so can be installed by double-clicking them, but if they're packaged as ZIP files you'll need to extract their contents.

Either way, open Device Manager by typing device manager into the Windows search box and clicking the 'Best match'. Click the arrow next to the type of hardware you want to update, then right-click the device and choose 'Update driver'. Select 'Browse my computer for drivers' (see screenshot below), click Browse and find the folder containing the drivers you downloaded – click 'Let me pick from a list of available drivers on my computer' to view only relevant folders. Select the folder, click OK and tick the box to 'Include subfolders', then click Next to install the updated drivers.

You can also use Device Manager to update the drivers for your printer, network adapter, monitor and other hardware. Right-click a device, select 'Update driver' and choose 'Search automatically for updated driver software'. Windows will then search your PC and the web for the latest drivers. Although it does this through Windows Update, there's no harm in double-checking and it may speed up installation.


Update Drivers - HP OfficeJet 3830 series
How do you want to search for drivers?
Search automatically for drivers
Browse my computer for drivers
Browse my computer for drivers

Install drivers you download from the manufacturer through Device Manager.



Intel's 'Driver & Support Assistant' updates drivers for the company's hardware.

Install new drivers for your graphics card

Graphics-card manufacturers periodically release updates to improve the performance, security and features of their products. You can either download these from the company's website and install them through Device Manager - double-click 'Display adaptors' to view the name of your GPU – or use the manufacturer's driver-assistant tool to automatically identify and install the drivers you need.

You'll be prompted to install Nvidia's Update tool when you download a GeForce driver from its website (www.snipca.com/42961). AMD's 'Auto-Detect and Install' tool for Radeon graphics cards is available from **www.snipca.com/42962**, while a more advanced program called AMD Software: Adrenalin Edition, which also includes performance reports and game statistics, can be downloaded from **www.snipca.com/42964**.

You can get Intel's 'Driver & Support Assistant', which detects the latest drivers for the company's graphics cards, sound cards, processors and wireless network adapters, from **www.snipca.com/42963**, and use it to download and install available updates (see screenshot above).

BEST FREE TOOLS FOR UPDATING DRIVERS

As we mentioned on page 51, there are plenty of tools that claim to detect and update outdated drivers, but either charge you a hefty fee, come bundled with junk or install drivers from dubious sources. It's for these reasons that some tech experts suggest you avoid using driver updaters altogether and rely on Windows Update for the task. However, there are a few programs that do work as promised and give you more control over your drivers than Microsoft and device manufacturers do.

Here we review the three best tools for managing your drivers, which are all free, safe and reliable to use. We also reveal which driver updaters you should avoid.

GOLD AWARD
Snappy Driver Installer Origin

www.snipca.com/42966

Snappy Driver Installer Origin (SDIO) is by far the best tool for identifying outdated drivers, and installing newer and/or better versions. Free of charge, free of junk and lacking premium-only features, it's a program you can either use occasionally to try and fix performance problems, or regularly in tandem with Windows Update to keep all your device drivers updated.

To use SDIO, you first need to install its 20MB indexes pack, which scans your PC to detect which drivers need to be updated. You can then review the results and decide which ones to install. Unlike Windows Update, the program helpfully tells you when a driver is newer but "less optimal" than what's already installed, but it also includes unsigned drivers, which you should ignore.

Create a system restore point (1 in our screenshot below) before updating any drivers, so you can roll back if anything goes wrong. Installing selected updates is as simple as clicking the Install button 2 – recommended drivers are highlighted in bright green 3.

We like the control Snappy gives you over which updates to download, and that you can press Ctrl while hovering over an entry to compare your current driver version with the one that's available.

It's a portable tool that doesn't require installation, and lets you install drivers offline if you download its massive (26GB) collection of driver packs. SDIO's default interface isn't particularly attractive, but you can tailor it to your taste by applying a different theme

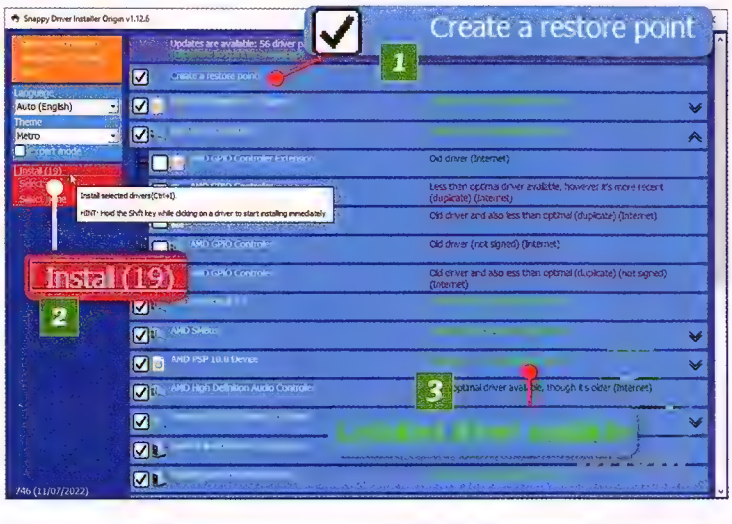
Note that Microsoft Defender's SmartScreen may flag SDIO as 'unrecognised', but it's totally safe to use – see its VirusTotal results at **www.snipca.com/41003** - so just click 'More info' then 'Run anyway'.

SILVER AWARD
DriversCloud

www.driverscloud.com

If downloading Snappy's driver packs sounds like too much hassle, DriversCloud offers an alternative – albeit less thorough – solution that partly works within your browser.

Select 'Scanning and drivers download' on its homepage (or go straight to **www.snipca.com/42968**), click Start Detection and choose 'Automatic installation' to download the DriversCloud



Snappy Driver Installer Origin is the best free tool for updating your device drivers.

HOW I USED SNAPPY TO UPDATE MY DRIVERS

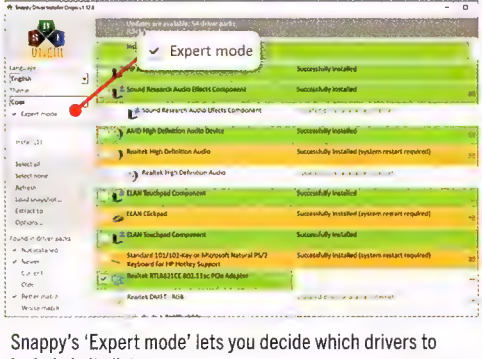
Having used Snappy Driver Installer Origin before, but not for several months, I knew the first thing I needed to do to update my drivers was click the button to download its indexes. Actually, that was the second thing after changing its theme to the more readable Coax option. Snappy then scanned my PC and listed drivers for all my devices.

Working through these from the top, I saw that updated drivers were available for my Realtek Bluetooth 4.2 adapter; several AMD controllers related to my processor and graphics card; audio components from different manufacturers; my laptop's ELAN touchpad and clickpad; and an HP driver for the keyboard. The latter was labelled 'Updated driver available which is also more optimal', which seemed like the best of both worlds, so I ticked the box next to it.

Other entries were initially more confusing because clicking the button next to them revealed a choice of drivers, some of which were 'older and less than optimal', while others were 'less than optimal but more recent'. After experimenting with options with SDIO's 'Expert mode' (tick the box on the left to activate this – see screenshot), I realised that the drivers it lists first are always newer and/or better than what you already have installed. So I ignored everything except the 'Updated driver available' recommendations and selected those entries – 17 in all. I then ticked the box to 'Create a restore point' and clicked Install.

Snappy downloaded and installed just over 2GB of drivers, which took around 15 minutes. I could have been more selective, but thought I might as well do the lot in one go. Once finished, I restarted my PC and found everything in working order. In fact it seemed to load and respond more quickly – or more snappily – than before.

Robert Irvine



Snappy's 'Expert mode' lets you decide which drivers to include in its list.

BEST FREE TOOLS FOR UPDATING DRIVERS

DriversCloud finds and recommends new versions of drivers installed on your PC

'agent'. Install and run this tool and it will scan your PC for drivers and open a web page showing its results. These include entries for your graphics card, motherboard and network adapter, which tell you the version number and release date of the drivers you have installed and whether newer versions are available.

If so, you can download those drivers, either individually or by clicking the Download button in the See Recommended Downloads box (see 1 in our screenshot below), and install them through the agent – click Save/Restore 2 to create a backup first. A handy offline mode lets you check your drivers without an internet connection and get the results when you're back online.

Sign up for a free DriversCloud account to be notified by email when a new driver becomes available. Just be careful not to click the deceptive ads on its website.

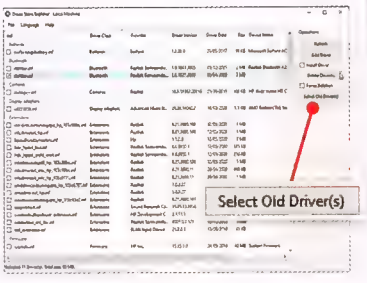
BRONZE AWARD
Driver Store Explorer

www.snipca.com/42969

This free tool is more of a driver manager than an updater. It provides a way to browse the Windows 'driver store' – the secure area of your hard drive where all your device drivers are installed – and remove outdated entries. You can also add drivers you've downloaded, but only if Windows can verify that the driver package is trusted.

Download the 'DriverStoreExplorer.v0.11.79.zip' file from **www.snipca.com/42970**, extract the contents and double-click the 'Rapr.exe' file. Click 'More info' then 'Run anyway' if you get a security warning. When it opens, you'll see a list of all your drivers, along with details of their type, device name and manufacturer, version number, release date and size.

Click the Select Old Driver(s) button (see screenshot above) to tick the boxes next to old versions of drivers that have been superseded by updates, but that still take up space on your PC. Click 'Delete Driver(s)' to remove these, taking care not to delete anything you're unsure about. Tick the Install Driver box and click Add Driver to install a new driver to the store (if Windows allows it). Usefully, you can click the File menu to export the list of your drivers, or back them up to an external drive.



Driver Store Explorer lets you manually remove old drivers and add new ones.

EXPERT TIPS FOR UPDATING YOUR DRIVERS

Remove drivers left behind by old devices

Every device that you remove or replace on your PC – whether it's a printer, webcam or graphics card – leaves its drivers behind on your hard drive. As well as taking up valuable space, these drivers can clash with newer devices and prevent them from working. We've already explained how to use Driver Store Explorer to delete old driver packages from the Windows driver store, but you can also remove leftover drivers through Device Manager.

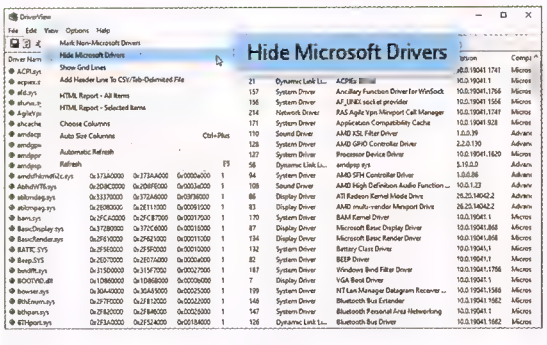
By default, Device Manager doesn't list drivers for devices that have been removed, but you can tweak Windows to show these entries. Type cmd into the Windows search box and click 'Run as administrator' under the Command Prompt result.

When Command Prompt opens, type set devmgr_show_nonpresent_devices=1 and press Enter – you can copy and paste this command from our Pastebin account (**www.snipca.com/42974**). Next, open Device Manager by typing device manager into the Windows search box and clicking the 'Best match'. Click the View menu and select 'Show hidden devices' (see screenshot below left). Click each device category in the Device Manager list and look for entries whose icons are greyed out. These are drivers for devices that are no longer connected to your PC. Right-click a device and click Uninstall to remove its drivers from your system, free up space and prevent potential conflicts.

Discover which companies made your drivers

One obstacle to downloading the latest drivers from the manufacturer's site is that you might not know which company made the device. Help is at hand from a tiny, free and portable tool called DriverView from the prolific developer NirSoft (**www.nirsoft.net**). This reveals all the drivers currently loaded on your PC, including details of their corresponding hardware, manufacturer, driver type, version number and more.

Download DriverView from **www.snipca.com/42975** (the link is below the Feedback



DriverView tells you which companies aside from Microsoft made your drivers.

heading about two-thirds of the way down the page), then extract the contents of its ZIP file and double-click 'DriverView.exe'. The program will load a comprehensive list of drivers, so you can quickly see the relevant companies for specific components.

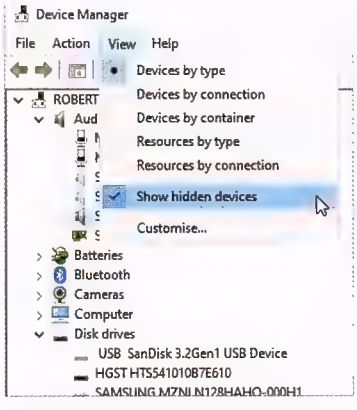
You'll notice that the majority of your drivers are made by Microsoft, so will be updated automatically through Windows Update. You can hide these by clicking the View menu and choosing Hide Microsoft Drivers (see screenshot above)

Another useful option lets you right-click an entry and choose Google Search to find info about that driver online. In addition, you can select multiple items then right-click and choose Save Selected Items to save their details as a text file.

Use your PC manufacturer's driver updater

If you don't trust Windows Update to keep your drivers up to date, and you'd prefer not to use a third-party tool, you could try your PC manufacturer's own driver updater. This will ensure you only receive updates that are compatible with the exact make and model of your system.

For example, you can scan your Dell computer for missing and outdated drivers, and install the latest updates using its 'Drivers & Downloads' service (**www.snipca.com/42976**). Similarly, HP's Support Assistant, which you can download from its 'Software & Drivers' website (**www.snipca.com/42977**) will identify driver problems and recommend updates that you can download and install.



Show hidden devices in Device Manager to remove old leftover drivers.

Reverse driver updates that cause problems

As we've mentioned, newer isn't always better when dealing with drivers, and updates can cause problems ranging from lost sound and error messages to excessive memory usage and system crashes. Thankfully, it's usually easy to undo a problematic driver update. Launch Device Manager in Windows 10 or 11, find the device that's misbehaving and double-click it. When the Properties box opens, click the Driver tab and select Roll Back Driver.

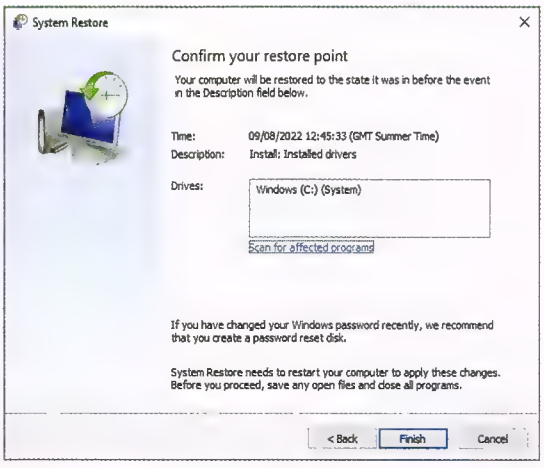
If rolling back to a previous version of the driver doesn't help or isn't available, choose Uninstall Device then click Uninstall. With a USB device, you can simply unplug it from your PC, then reconnect it and Windows will search for and install the best available driver.

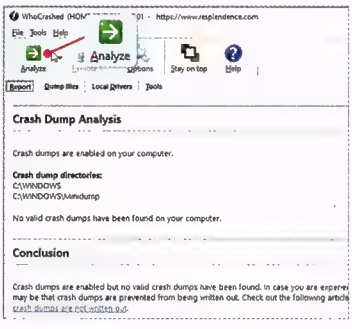
With internal components such as your sound card, click the Action menu in Device Manager and choose 'Scan for hardware changes'. This will prompt Windows to re-detect the device and download the correct driver.

If you're unsure which updated driver is causing the problem, you can perform a system restore to revert your PC to a state when everything was working properly. To do so, type system restore in the Windows search box and select 'Create a restore point' to open the System Properties box. On the System Protection tab, click System Restore and select 'Recommended restore' – this may mention that a restore point was created when you installed drivers. Click 'Next' then Finish and choose Yes to restore your system.

Identify which drivers are causing crashes

If your PC has started crashing or rebooting for no apparent reason, a corrupt driver is probably to blame, but identifying the culprit can be tricky. One of the best ways to diagnose the problem is to run WhoCrashed (**www.snipca.com/42980**). This free tool, which was recently updated to add support for Windows 11, analyses the 'crash dump' files to determine which driver caused the crash. You can then replace that driver with a functioning version using one of the methods or tools we've covered here.


System Restore
Confirm your restore point
Your computer will be restored to the state it was in before the event in the Description field below.
Time: 09/08/2022 12:45:33 (GMT Summer Time)
Description: Install: Installed drivers
Drives: Windows (C:) (System)
Scan for affected programs
If you have changed your Windows password recently, we recommend that you create a password reset disk.
System Restore needs to restart your computer to apply these changes. Before you proceed, save any open files and close all programs.
< Back
Finish
Cancel



ABOVE Restore your system to a point before you carried out a troublesome driver. **LEFT** Run WhoCrashed to find out which corrupt driver is causing your PC to crash.

To use WhoCrashed, download the Free Home Edition from **www.snipca.com/42981**, install and launch the program, and click the Analyze button. Once the analysis is complete, scroll down to read the report about the responsible driver and suggestions on how to fix the problem.

Alternatively, you can use the Reliability Monitor that's built into Windows to try and identify your troublesome driver. Type reliability into the Windows search box and select 'View reliability history'. This will show you recent hardware and Windows failures, and may list malfunctioning device drivers under 'Critical events'. Click the 'View all problem reports' link for more information.

PC BUILDER

System News

Nvidia launches GPUs as a partner launches a bombshell, Mark Williams covers a hectic month in GPU land.

Mark Williams
Mark is an IT professional with a strong interest in voiding warranties.

EVGA ends 20-year Nvidia relationship

Nvidia's largest Add In Board (AIB) partner in the US, EVGA, made waves in the industry when it was announced that it would be ceasing its partnership with Nvidia and won't be producing new graphics cards for them going forward.

Citing disrespectful treatment as the primary reason, not financial, although the financial side of things was a contributing factor, EVGA decided to take a stand against Nvidia as a matter of principle.

> "When asked if the decision to pull the plug was difficult, EVGA's CEO responded, "this is easy, working with Nvidia was hard"."

Giving examples like Nvidia withholding basic information such as card MSRP and GPU costs until they're announced to the general public by Nvidia, EVGA had no idea what its own products would cost until Nvidia made the public announcement. On top of that, Nvidia sets floor and ceiling prices for its cards, restricting creativity by AIBs (for cheaper or more expensive variants). There's also the issue that Nvidia's own Founders Edition cards are sold cheaper than AIB cards can be produced for. These and many other issues have been happening for multiple generations of cards now. The RTX 4000 series is the straw that broke EVGA's back.

EVGA has said that it's losing hundreds of dollars on each card it sells in the upper end of the RTX 3000 series as a result of Nvidia's antics.

When asked if the decision to pull the plug was difficult, EVGA's CEO responded, "this is easy, working with Nvidia was hard". This helps explain why card prices recently remained so high, until enough AIB's complained to Nvidia that they couldn't get rid of any more stock, forcing Nvidia to lower prices. It seems Nvidia wants to artificially control the costs of its cards to its own benefit.

EVGA has stated that while a big part of its revenue will disappear, it was laughably the least profitable segment of its business. EVGA is still profitable and will continue making power supplies and motherboards. In fact, if EVGA doubles its PSU sales, the profit from that alone would make up for the lost profits it was making selling graphics cards.

When asked if EVGA might switch to producing AMD or Intel cards instead, its CEO flat out didn't want to entertain the idea. It seems Nvidia has turned EVGA off graphics card production entirely.

Nvidia's product stack is in stress

With Add In Board partners having an estimated year's worth of RTX 3000 series supply on their hands, Nvidia is being forced to launch the RTX 4000 series alongside its own RTX 3000 series. This means pricing it higher than the 3000 series. Nvidia confirmed between $1,659 for the RTX 4080 12GB up to an eye-watering $2,959 for the RTX 4090. This fact alone seems to be the reason behind the RTX 4080 12GB's name, instead of "RTX 4070", as Nvidia needs to make it appear to be worth the price to customers.

With 4nm production locked in at TSMC, Nvidia must produce and sell RTX 4000 GPUs, it's bound by contract. This means there should be plenty of availability of Nvidia's GPUs for the foreseeable future while we wait for possibly a year's worth of supply of RTX 3000 cards to sell through. ■

Market Watch

A sampling of PC systems available this month

JW COMPUTERS GMR OSPREY 3060

$2,699 | tinyurl.com/APC513JWC

This mini ITX build does its best to make a good argument for itself. With an 8-core processor and an RTX 3060 it's more than capable of giving a good gaming experience at 1080p or even 1440p under the right circumstances. With a 240mm AIO keeping the CPU cool, a vertical GPU mount that lets the graphics card breathe in fresh air from the side of the chassis and an SSD with a heatsink, this system won't have any cooling issues at all, which can often be the situation in such small builds.

The problem is the price. With far inferior specs than the JW system while costing $100 more, you're paying a hefty toll for the benefit of its diminutive size.

CPU: AMD Ryzen 7 5700X; **Cooler:** MSI Mag Core Liquid 240R V2; **Motherboard:** Asus Strix B550-I; **Graphics:** Gigabyte RTX 3060 Eagle OC 12GD 2.0 LHR; **Memory:** Corsair Vengeance RGB RS 16GB DDR4 3600MHz; **Storage:** WD Black SN850 1TB Gen4 NVMe SSD with Heatsink; **Power Supply:** Coolermaster V850W; **Case:** Coolermaster NR200P Max.

TI COMPUTERS TI INFINITY GAMING 12700K

$3,365 | tinyurl.com/APC513TIC

Sporting Intel's 12700F CPU, this system offers up a lot of CPU power for your money with up to 20 threads to chew though your tasks. Matched with a roomy 32GB of RAM there's not much this system will struggle with for any power user that likes to run demanding productivity tasks.

The RTX 3080 is only the 10GB version which might cause issues sooner rather than later compared to higher buffer models, but currently it's quite solid for most gaming tasks including 4K.

1TB of SSD capacity and an 850W PSU round out a reasonable but not particularly interesting build.

CPU: Intel i7 12700KF; **Cooler:** Noctua D15 Black; **Motherboard:** Intel Z690-based; **Graphics:** RTX3080 10GB **Memory:** 32GB DDR4 Kingston 3200MHz; **Storage:** 1TB NVMe M.2 PCIe SSD; **Power Supply:** Antec 850W; **Case:** Antec NX800.

BPC TECHNOLOGY SIREN VORTEX

$2,399 | tinyurl.com/APC513BPC

An RTX 3080 Ti in a system costing under $2,500 seems unheard of! It's real though, and it seems some smart shortcuts have been taken to hit this price point, but boy is it a juicy proposition. The 5700X CPU to be fair isn't far off a regular 5800X so you shouldn't see too much in the way of bottlenecking the GPU, good choice there.

The motherboard is about as entry-level as you'd want to go, the RAM isn't anything special either but is quite adequate. The SSD is only PCIe 3.0 capable but at least there's 1TB of it and with a beefy PSU to power the beastly graphics card, this rig is a 4K gaming monster for only relatively a few pennies.

Superb performance on offer here for the price, for pure gaming this is hard to look past.

CPU: AMD Ryzen 7 5700X; **Cooler:** OEM; **Motherboard:** Asrock B550M Pro4; **Graphics:** Gigabyte GeForce RTX 3080 Ti Gaming OC 12GB; **Memory:** ADATA XPG Spectrix D41 RGB 16GB DDR4 3200MHz; **Storage:** Kingston NV1 1TB PCIe 3.0 NVMe M.2 SSD; **Power Supply:** EVGA 850 GQ 850W; **Case:** MSI MPG Gungnir 111R.

CENTRE COM KARUZA PANDORA

$2,599 | tinyurl.com/APC513COM

This flashy system offers quite a bit of compute for the price. Sporting a 12-core 24-thread CPU it'll chew through any heavy multithreaded tasks well enough. Paired with an RTX 3070 it'll have your back with gaming too. However, if your productivity tasks heavily require the GPU for processing, perhaps look elsewhere as the 8GB of VRAM will quickly become a limiting factor.

The 16GB of system RAM feels a little tight for CPU grunt it's paired with too and may also quickly feel limiting depending on what you're doing.

This seems like a gaming-first system that'll let you dabble with CPU-heavy workloads. Reasonable value for money.

CPU: AMD Ryzen 9 5900X; **Cooler:** Cooler Master MasterLiquid ML240 Illusion AIO; **Motherboard:** Gigabyte B550 Aorus Elite AX V2 WIFI; **Graphics:** Gigabyte GeForce RTX 3070 Gaming OC 8GB R2.0 LHR; **Memory:** Corsair Vengeance RGB RS 16GB DDR4 3200MHz C16; **Storage:** Kingston SNVS 1TB NV1 M.2 NVME SSD; **Power Supply:** Gigabyte P850GM 850W; **Case:** Karuza Elite.

PC BUILDER

Blueprints

Value- and performance-driven hypothetical builds

BUDGET

A perfect balance between price and peformance.

Creating a budget build for under $2K may not result in a top-end machine, but it does force you to think about how to spend your money wisely. With new AMD and Intel chips coming towards the end of the year, we hope this will reduce the price of the current budget-end CPUs, freeing some cash to spend elsewhere.

We're not quite there yet, though. Our AMD machine sees two changes this time. First, swapping from Asrock to MSI for our GPU choice. Out goes the 6650 XT Challenger D OC and in comes the 6650XT MECH 2X OC. We've managed to maintain an OC card for similar money, so it makes sense. We can't complain about out-of-the-box overclocking for this price.

By changing our previous Corsair Vengeance LPX CL16 to PNY's XLR8 Gaming Epic-X RGB we also get a splash of colour in our AMD machine. Costing $15 less and performing similarly, it's a cheap upgrade. A price hike in our previous HDD meant that we had to bring in Seagate's SkyHawk Surveillance 7200 HDD to replace the Seagate Barracuda. This change is made on both the AMD PC and the Intel one.

Over on the Intel build, we're greeted by a small savings. We've spared $10 on our GPU by shrinking it down to an ITX form factor card. The MSI RTX 3060 Ventus 3X OC is replaced by another MSI RTX 3060, the Aero ITX OC. It's an interesting choice but also retains the same power as the GPU it knocks off the podium.

As well as bringing the Seagate SkyHawk Surveillance 7200 HDD into the Intel machine, we also add the splash of colour provided by the RAM from the AMD budget build. This PNY XLR8 Gaming Epic-X RGB RAM, like on the AMD machine, replaces a similarly speedy memory but adds the RGB element into the case. Overall, there haven't been too many changes, just a few subtle swaps to keep both builds fresh.

"With new AMD and Intel chips coming towards the end of the year, we hope this will reduce the price of the current budget-end CPUs, freeing some cash to spend elsewhere."

AMD INGREDIENTS

Part		Price
Case	Corsair 4000D Airflow	$120
PSU	550W Corsair CV550 80+ Bronze	$75
Mobo	MSI B550M PRO-VDH WiFi AM4	$149
CPU	AMD Ryzen 5 5600X	$299
GPU	MSI Radeon RX 6650 XT Mech 2X OC 8GB NEW	$649
RAM	16GB (2 x 8GB) PNY XLR8 Gaming EPIC-X RGB @ 3600MHz NEW	$95
SSD	500GB MSI Spatium M450 PCIe 4.0 M.2 SSD	$89
HDD	4TB Seagate SkyHawk Surveillance 7200 HDD NEW	$129
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$1,665

INTEL INGREDIENTS

Part		Price
Case	Corsair 4000D Airflow	$120
PSU	550W Corsair CV550 80+ Bronze	$75
Mobo	Asrock B660 Pro RS LGA 1700	$179
CPU	Intel Core i5-12600	$369
GPU	MSI GeForce RTX 3060 Aero ITX OC 12GB NEW	$569
RAM	16GB (2 x 8GB) PNY XLR8 Gaming EPIC-X RGB @ 3600MHz NEW	$95
SSD	500GB MSI Spatium M450 PCIe 4.0 M.2 SSD	$89
HDD	4TB Seagate SkyHawk Surveillance 7200 HDD NEW	$129
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$1,685

"Prices have stayed pretty much the same as the previous month's builds so, again, we're left waiting for the new chips to come out to hopefully see a drop in the current-gen processor prices."

MID-RANGE

A game-ready machine that can also handle demanding work.

At around $1,000 more than the budget PCs, our mid-range offerings from both AMD and Intel allow us the freedom to improve our gaming capabilities by some margin. Here, we will be aiming for a smooth 1440p experience. Starting with our AMD mid-range build, there aren't too many changes this time around.

Prices have stayed pretty much the same as the previous month's builds so, again, we're left waiting for the new chips to come out to hopefully see a drop in the current-gen processor prices. Alongside this processor is the Asrock Radeon RX 6800 XT Phantom Gaming D OC card. Overclocked from the get-go, this mighty GPU is still available for aroun $860. We've introduced the HDDs from the budget machines here – we previously had the Seagate Barracuda, but these hiked in price so Seagate's SkyHawk Surveillance 7200 HDD replaced it in both mid-range builds.

We also decided to upgrade from 500GB capacity to 1TB. For an extra $30 on the Intel side, we brought in the 1TB Adata XPG Gammix S70 that we featured in our build this issue. With snappy performance, it's great value at this price. For the AMD machine, a 1TB Crucial P5 SSD replaces the previous 500GB Western Digital Black SN850. It's $70 more expensive, but we get a similar performance and double the capacity.

Another change on both builds is the introduction of the Nzxt C750 80+ Gold PSU. It replaces the EVGA SuperNova 750 GT 80+ Gold which was previously on sale. Lastly, another sale has ended for our MSI GeForce RTX 3070 Ventus 2X OC GPU. Annoyingly, this has increased by $70 but that's still a decent price for an OC RTX 3070 graphics card.

AMD INGREDIENTS

Part		Price
Case	Nzxt H7 Flow	$209
PSU	750W Nzxt C750 80+ Gold NEW	$179
Mobo	Asrock X570 Steel Legend AM4	$299
CPU	AMD Ryzen 7 5800X	$449
Cooler	Cooler Master Masterliquid ML240L RGB V2	$95
GPU	Asrock Radeon RX 6800 XT Phantom Gaming D 16GB	$859
RAM	32GB (2 x 16GB) Corsair Vengeance RGB RT CL16 @ 3600MHz	$269
SSD	1TB Crucial P5 NVME M.2 PCIe 4.0 NEW	$179
HDD	4TB Seagate SkyHawk Surveillance 7200 NEW	$129
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$2,727

INTEL INGREDIENTS

Part		Price
Case	Nzxt H7 Flow	$209
PSU	750W Nzxt C750 80+ Gold NEW	$179
Mobo	Asrock Z690 Pro RS LGA 1700	$249
CPU	Intel Core i7-12700F	$559
Cooler	Cooler Master Masterliquid ML240L RGB V2	$95
GPU	MSI GeForce RTX 3070 Ventus 2X OC 8GB	$899
RAM	32GB (2 x 16GB) Corsair Vengeance RGB RT CL16 @ 3600MHz	$138
SSD	1TB ADATA XPG GAMMIX S70 M.2 PCIe 4.0 NEW	$205
HDD	4TB Seagate SkyHawk Surveillance 7200 HDD NEW	$129
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$2,722

"We are excited for the new components to come along in the not-too-distant future. This should spice up our machines either with some big price difference or some new components."

TURBO

The maximum PC.

We don't want to repeat ourselves too much, but our Turbo machines are only going to get more exciting when the new CPUs and GPUs eventually start to roll out over the next few issues. Of course, these new parts aren't going to void the current processors and graphic cards we have in place because regardless of what's coming, you can still get some monstrous performance from these Turbo builds. There's plenty of life left in them yet.

We have two changes on the Turbo AMD build, starting with a motherboard swap. We say goodbye to the previous MSI MEG X570 Unify and replace it with the Gigabyte X570 Gaming X mobo. At just under $300, it has all that we'll need for future-proofing and performance at this price point. Another change is to replace both our SSDs in our Turbo models. Western Digital's SN850 has proved to be a super-snappy SSD that we have used multiple times in our own builds as well as this segment of the magazine. As soon as the SN850X was released (reviewed on page 42), which is a sharper offering at a similar price, we knew we wanted to include it. Sequential read speeds of 7,300MBps and write speeds of 6,600MBps make this one hot SSD.

The Asrock OC Formula Radeon RX 6950 XT GPU is well priced at around $880, so that's a new entry. Also, the CPU that runs this ship, the AMD Ryzen 9 5950X, is still a mighty fine processor and it's fallen in price by $110 from last month. As for the Intel machine, other than the SN850X coming in, we upgraded our PSU to a 1000W unit, which the AMD build also gets. Specifically, the 1000W Corsair RMx 80+ Gold should cover the extensive power draw from both our Intel Core i9-12900K and the Gigabyte GeForce RTX 3090 Ti Gaming Gaming OC GPU.

There were no real price increases to worry about this issue. So, we are excited for the new components to come along in the not-too-distant future. This should spice up our machines either with some big price difference or some new components.

AMD INGREDIENTS

Part		Price
Case	Phanteks Enthoo Pro 2 Tempered Glass	$220
PSU	1000W Corsair RMx 80+ Gold NEW	$285
Mobo	Gigabyte X570 Gaming X ATX AM4 NEW	$289
CPU	AMD Ryzen 9 5950X	$819
Cooler	Nzxt Kraken X73 73.11 CFM 360mm	$239
GPU	Asrock OC Formula Radeon RX 6950 XT 16GB NEW	$879
RAM	64GB (2 x 32GB) G.Skill Trident Z RGB DDR4 @ 4000MHz CL18	$489
SSD	1TB WD Black SN850X M.2 PCIe 4.0 NEW	$249
HDD	6TB WD Blue 5400 HDD	$189
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$3,718

INTEL INGREDIENTS

Part		Price
Case	Phanteks Enthoo Pro 2 Tempered Glass	$220
PSU	1000W Corsair RMx 80+ Gold NEW	$285
Mobo	Asus TUF Gaming Z690-Plus WIFI DDR5 LGA 1700	$389
CPU	Intel Core i9-12900K	$909
Cooler	Nzxt Kraken X73 73.11 CFM 360mm	$239
GPU	Gigabyte GeForce RTX 3090 Ti Gaming Gaming OC 24GB	$2,249
RAM	64GB (2 x 32GB) G.Skill Ripjaws S5 DDR5 @ 5600MHz	$339
SSD	1TB WD Black SN850X M.2 PCIe 4.0 NEW	$249
HDD	6TB WD Blue 5400 HDD	$189
OS	Windows 10 Home 64-bit OEM (Windows 11 Compatible)	$60
Total		$5,128

The best as voted by Australians

Congratulations to the award-winning tech brands that took out honours in the 13th annual Mozo People's Choice Awards

TELEVISIONS
TCL, JVC, Hisense, Sony, Samsung

HEADPHONES
Bose, Apple, Jabra, Sennheiser, Anko, Sony, Samsung

SMARTPHONES
Apple, Google Pixel Oppo

mozo.com.au

mozo
The money saving zone

QUICK TIPS

The problem solvers

The APC team field problems across the spectrum of devices and software. Learn a new trick or fix you can use.

Driver Updater query

I have a question about driver updaters. AVG charged me for such a program recently. I wondered why I was being charged for this since I had a two-year subscription to its Ultimate package. Turns out AVG has a new software app that updates not only its software drivers but everyone else's drivers too.

Oddly, a company like Microsoft charges third-party companies that use its operating system lots of money to 'authenticate' drivers, but suddenly, AVG has 20,000 other manufacturer drivers to update. It's strange that AVG has moved into this area.

> "The downside of relying on WHQL drivers is that they're rarely the latest available version and prioritise stability over performance."

Could you possibly shed light on what is going on with driver updaters and why software manufacturers aren't updating their own drivers? Maybe they are? What is AVG's game here? And why do we need such an app?

Steven Sherk

APC responds: Driver updates are like software updaters in that they're designed for convenience by allowing you to keep all your drivers up to date with a single program. At least that's the theory.

This means that AVG – or indeed any other driver updater – isn't involved in developing driver updates; instead, it's merely acting as a convenient conduit to them. Hardware manufacturers continue to create their own drivers, then either sign them themselves or submit them to Microsoft for WHQL certification (Microsoft hasn't charged a fee for these tests since 2014).

If a driver is WHQL-certified, it will be added to Microsoft's driver database and can be installed and updated through Windows Update. After installing a fresh copy of Windows for the first time, all installed drivers are WHQL-certified.

The downside of relying on WHQL drivers is that they're rarely the latest available version and prioritise stability over performance. You are encouraged to visit the manufacturer's own website to see if more up-to-date (but not WHQL-certified) drivers are available. Install these and you may improve performance and gain new features, but you're relying on the driver manufacturer to provide updates.

If you're lucky, some hardware manufacturers will supply automatic update checkers as part of their software installations, Nvidia's GeForce drivers being a case in point. Most hard drive manufacturers offer additional tools that include driver and firmware checkers. That's all well and good, but this piecemeal approach leaves big gaps in your driver update arsenal.

One option might be to bookmark the various support pages covering all the components in your machine, then set yourself a regular day (say once a month) to check each website to see if driver updates are available.

If that's too much hassle, you're struggling to identify certain bits of hardware, or are unable to find drivers, a driver update tool may help. Check out our feature on page 74 in this issue covering all your options.

NAS build query

I was lucky enough to source an Asrock J5040-ITX motherboard and an InWin IW-MS04 case and was wondering if you could provide some tips on incorporating them into my NAS project. It's been a long time since my last build (I'm 72 years old) and I would really appreciate some help, especially with the HDD for the OS as I'm not quite sure where to place it. Thank you very much for any help you can provide! I'm looking forward to running my own NAS.

Frank D Gunsetor

APC responds: Luckily, our own NAS is built around the same components Frank used for his NAS, so he was able to provide the specific advice needed. Let's start with the best placement for the OS drive, which we'll assume is a 2.5-inch SSD. There's a handy space on the side of the chassis where you can slide in your SSD and secure it to the case (see photo). The good news is that there are enough SATA power connectors on the IW-MS04's built-in PSU to cover the boot drive as well as the four additional drive bays.

Where you may come unstuck is in the fact the J5040-ITX mobo only has four SATA connectors, a problem resolved by adding a two-port PCI-E SATA card as outlined in the 'Build your own NAS' feature. It doesn't matter which SATA ports you use for the four 3.5-inch drives, but make sure your SSD boot drive is connected to one of the Intel SATA ports (SATA3_1 or SATA3_2) for maximum performance.

Frank was also interested in using the board's M.2 socket to add Wi-Fi capabilities to his system. APC prefers wired connections and would reach for a USB Wi-Fi adapter if required, but you can fit the Intel Wi-Fi 6 AX200 (Gig+) M.2 module to this slot to add Wi-Fi 6 and Bluetooth 5.1. Linux drivers exist for kernel 5.1 or later, which means it should work seamlessly with Ubuntu 22.04 LTS or later (see **www.intel.com/content/www/us/en/support/articles/000005511/wireless.html** for details on installing it manually).

Plex password breach

I've just received an email from Plex informing me about a possible security breach and the need to reset my password. What does this entail and is it time to switch to another media server?

Joff Hopkins

APC responds: There's no need to move your media to another server, Joff – although if you're unhappy with Plex you might

There's usually space for an SSD in a NAS enclosure.

want to check out Jellyfin (**https://jellyfin.org/**) as a free and open-source alternative (see our Head to Head on these two apps on page 30 of this issue). The good news is you can install and run it alongside Plex using the same media libraries, so you can test it without committing to the switch.

But going back to the point: there's no need to move to another media server, because Plex has been open and transparent about the password breach, and moved swiftly to ensure everyone has changed their passwords. So, with that in mind, let's start by changing your Plex password.

Log into your account settings through your web browser, then click your account avatar in the top right-hand corner and choose 'Account Settings'. Scroll down to the Security section and click Edit next to Password. Check 'Sign out connected devices after password change' before choosing a new, strong password (APC recommends a 14-character password, randomly generated by your password manager with a mix of numbers, letters, and symbols. Once done, you'll be logged out, so log back into your account and return to the Security section to enable 2FA for an additional layer of protection.

Note that choosing 'sign out connected devices' will also unlink your media server from your account, which means you'll need to 'reclaim' it. Plex offers detailed instructions on doing this at *https://support.plex.tv/articles/account-requires-password-reset/* but assuming you're on the same network as your Plex server, the simplest thing to do is open a new browser tab and go directly to the server's local IP address – for example, **http://192.168.35.1:32400/web/** – finish the setup wizard and you'll be warned the server is unclaimed and not secure. Click the 'Claim it now' button and follow the prompts to relink the server to your main Plex account.

Finally, you'll need to sign back in on all your playback devices – it's a pain, but at least Plex supports signing into TV apps using a four-digit code you can obtain by logging into your Plex account on any web browser. And don't worry about any remote users not heeding the call to reset their passwords, Plex has made this a mandatory step, so until they sort out their password they won't be able to access your server.

CS3-friendly upgrade

I have a computer running Adobe CS3 – it's a Gigabyte GA78LMT-USB3 with AMD FX 8350 and Nvidia Quadro K620 powered by Windows 7. It seems that to keep CS3 I must stick with what I have and live with it. I don't know if the mobo is compatible with a new PCI-E 4.0 graphics card, but do I need all the power that the graphics card requires? I have a 450-watt power supply and can't see an affordable update path. Due to the ridiculous power demanded by gaming GPUs is there any upgrade path for low-power users?

Leslie Nelson

APC responds: Ordinarily, we would have pointed you towards running Adobe CS3 in a virtual machine to enable you to keep it running without hobbling your need to upgrade your system. Ordinarily. The problem is that Adobe's CS3 activation servers were discontinued a while back, and after the company made an installer with offline activation available to download for a short period, that has now been removed, meaning CS3 is completely dead.

This highlights another potential issue, what happens if your current install stops working and can't be resurrected? APC sympathises with your reluctance to upgrade – why does Adobe insist we rent software instead of purchasing it outright? – but wonders if now isn't the time for a discussion about what you use CS3 for and whether you can transfer to a more up-to-date package from a rival publisher. Serif's Affinity range (**https://affinity.serif.com**) offers alternatives to Photoshop, InDesign, and Illustrator that can be bought outright. The total cost of all three products is under $255, so it may be worth exploring to see how other CS users have fared in migrating.

In terms of upgrading your current system to continue running CS3, there's little to be gained from swapping out the graphics card. The mobo only supports the PCI Express 2.0 standard for starters, but the graphics card is of little importance with 2D graphics. Upgrades that will make a difference, if you haven't already applied them, would be to replace a platter-based hard drive with an SSD boot drive and to max out your RAM to 32GB.

Although your motherboard only supports SATA-II speeds, there's plenty of bandwidth for an SSD drive to deliver a noticeable uplift in performance, from simple loading of apps to overall responsiveness. If you're determined to keep CS3 running on this system, those are the two upgrades to focus on. ■

WINDOWS

Fix PC problems with Windows 11

Nick Peers is armed and ready to solve the most common Windows 11 problems.

YOU'LL NEED
WhoCrashed Home Edition (www.resplendence.com/whocrashed)

Tweaking.com Windows Repair Tool (www.tweaking.com)

Got a problem with your PC? The answers to your woes lie somewhere buried deep inside Windows itself, you just need to know where to find them. Windows 11 may not introduce any new troubleshooting tools to the mix, but it continues to support tried and tested tools, including Device Manager, Event Viewer, and a host of troubleshooters.

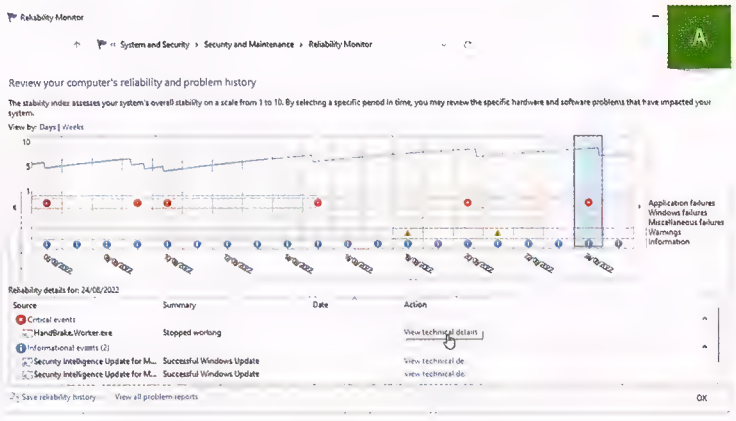
We'll take an in-depth look at these as well as some other useful tools. Reliability Monitor is built into Windows, while the third-party tools we showcase – WhoCrashed and Tweaking.com's Windows Repair tool – are included because they provide convenient access to system logs and tools such as System File Checker and Windows' powerful disk-checking tools.

> "The answers to your problems lie hidden somewhere, either within your PC or out on the wider internet. "

If the tools featured can't provide a solution to your problem, they will at least arm you with lots of useful information with which you can go hunting for solutions elsewhere using the power of the web. The answers to your problems lie hidden somewhere, either within your PC or out on the wider internet.

Get a system health overview

If you're plagued by a poorly performing system, but don't know exactly where to look, type 'reliability' into the Search box and click 'View reliability history' to open the Reliability Monito – yes, it's still there in Windows 11. This provides an overview of your system's stability over the past 12 months – you'll get an overall rating of 1 to 10, updated daily. Whenever failures or warnings are recorded in the Events log, your rating drops accordingly. The longer it goes without problems, the higher the ratings go.



Of more use are the summaries beneath the rating line graph – here, you'll find a list of notable events for the selected day. Look for those where failures or warnings have been recorded, then select the most recent day on which they occurred **[Image A]**. You'll get a summary of the problems recorded, including the application name and a short explanation, plus a date and time of the event. Click 'View technical details' for a fuller description. Make a note of key details, such as the application name, any 'faulting modules', and exception codes, then skip to step 3 to see if you can track down any potential solutions online.

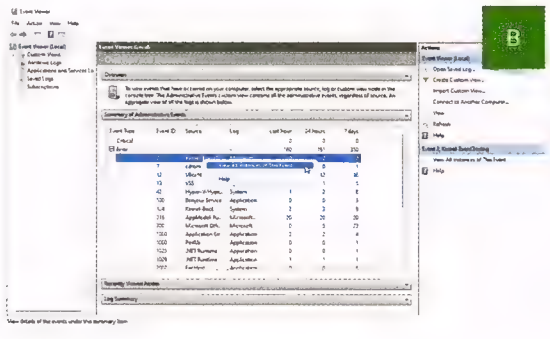
Check Event Viewer

While Reliability Monitor will highlight critical problems, Event Viewer offers a broader overview of your system. This handy tool can be launched via a search for 'event' or you can simply press Win-R, type eventvwr and hit Enter. Event Viewer provides access to your system logs, which chronicle everything from mundane day-to-day events to warnings, error messages, and 'critical' events, which often include crashes (assuming the system is able to log something when the crash occurs. Skip to the next step if you suffer a blue-screen crash).

Click '+' next to a section to expand it and view a summary of the events recorded. Focus on events that last occurred around the time your problem manifested itself using the three date/time ranges (Last hour, 24 hours, 7 days) for potential matches **[Image B]**.

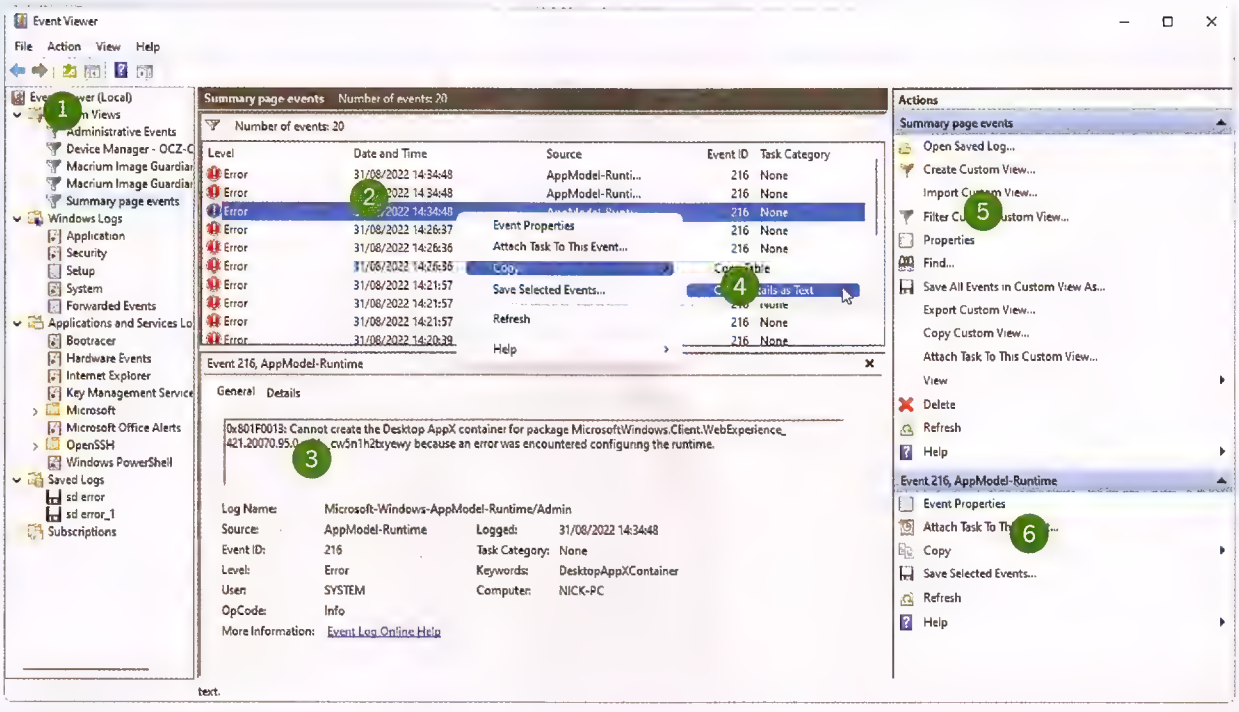
Double-click an event to open its Summary page, then use the annotation to help identify possible events that correlate to the problem you're investigating. In many cases, the event will have occurred multiple times. Review all instances, focusing on the time and date each instance occurred, which you may be able to link directly to your problem.

Don't assume this single event is the only one linked to your issue, however. Go through all event types under 'Critical', 'Error', and also possibly 'Warning' to see if multiple events are occurring at the same time. Make a note of each one, then read on to discover how to examine each one in more depth.



Search for help

Make a note of the description – the Details tab provides more technical data for those who may need it later. You'll see an 'Event



NAVIGATE EVENT VIEWER

1. FILTER VIEW

Event Viewer allows you to examine specific parts of your system by browsing the available list of logs. Alternatively, you can create your own custom views.

2. ERROR FREQUENCY

In isolated cases, errors and warnings can be ignored, but if they keep cropping up it's a good idea to investigate them further.

3. EVENT DETAILS

Try to include as much detail as the log gives you in your searches: Event ID, source (or filenames), and any error codes, plus key information from the description.

4. ASK OTHERS

If all else fails, right-click the event to copy its details to the clipboard. You can paste this into a web forum post when asking for help.

5. FILTER CURRENT VIEW

When viewing specific logs, click 'Filter Current…' to determine what's shown – for example, only critical, warning, and error events, which is where most problems are recorded.

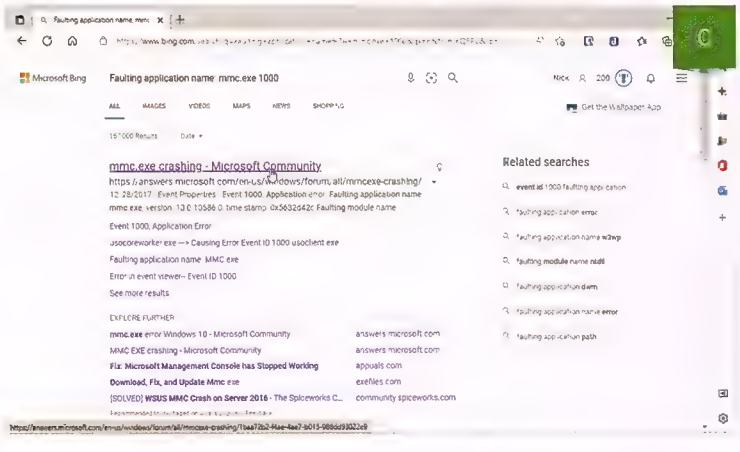
6. CREATE ALERT

By clicking 'Attach Task To This Event' (see the box) you can receive an on-screen alert whenever the system records this event in the future.

Log Online Help' link at the bottom of the General tab, but this has long since stopped working. From here on, you're relying on third-party help to dig deeper into your problem.

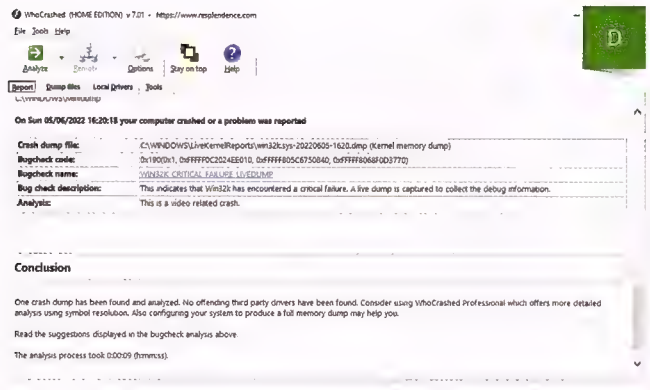
Make a note of the Event ID, Source, and description under the General tab in Event Viewer, then type these into a search engine (Bing or Google are best) and see what results come up **[Image C]**. You may find more troubleshooting information via a web page or forum.

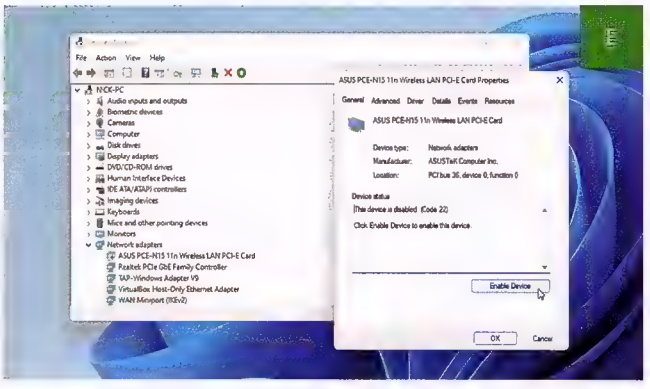
If too few results are returned, try searching for fewer words or omitting the Source or Event ID from your terms. If too many results come back, try narrowing it by including more information. For example, try to include any specific references to filenames in the event log or provide more general information, such as your version of Windows, hardware device, or software program.



A deeper dive into Event Viewer

What if you can't find the information you're looking for? It's likely the events you need to track are buried away. Try manually browsing the available logs to narrow your search. Expand Windows Logs in the left pane where you'll find logs organised into categories. Use Applications to search for





program-related problems and System for Windows and hardware.

Logs record all manner of information, though much of it is irrelevant when troubleshooting a problem. Click the Filter Current Log button in the right-hand pane to filter the list in different ways: by the time it occurred, the type of event (focus on critical, error, and warning), Event sources, IDs, keywords, or any various combinations of these. Click OK when that's done.

If you want to create a filter that provides you with information across multiple logs or wish to create a filter you can easily access in the future, click Create Custom View under 'Actions'. It works in the same way as the filter – to monitor more than one log with your custom view, click the Event logs dropdown menu and tick the logs you wish to include.

Click OK, then give your custom view a suitably descriptive name and choose where to save it within the Custom Views tree in the left-hand pane. Going forward you'll be able to access this view at any time directly from here – it's the perfect shortcut for targeted troubleshooting that will take an extended period to monitor and act upon.

Troubleshoot blue-screen crashes

Blue-screen errors, also known as STOP errors, can be a pain to troubleshoot, particularly if you're not quick enough to record the details before Windows reboots and attempts to bypass the problem. That's where a free tool called WhoCrashed Home Edition (**www.resplendence.com/whocrashed**) earns its corn.

Once installed, it's capable of analysing the system crash logs of your PC to produce a more coherent report you can use to troubleshoot. After installing, launch the program and click Analyse. Once complete, scroll down the Report window, where you'll be greeted with a list of all crash dumps on your system, complete with date and time (for corroboration). You'll see the usual technical information, including bugcheck codes and name, which is displayed on the blue screen after a crash and before your PC reboots.

Crucially, you'll also be given a description and an analysis of the crash **[Image D]**, which serve to help you understand why it occurred and what the likely culprit is. From here, you can click the bugcheck name to launch a Google search for articles and forum posts related to it and see what driver files are currently loaded (click Local Drivers).

Take the time to visit the Tools section, where you'll find shortcuts to key system tools and settings like Event Viewer and System File Checker. You'll notice certain advanced options, such as the Crash Dump Test, or the ability to stop Windows from deleting memory dump files, are restricted to the Pro version, which at the time of writing costs around $35. For most people, however, the free Home version is sufficient for your troubleshooting needs.

Fix driver issues

Whether you simply want to verify the state of your drivers or strongly suspect a driver is the cause of a particular problem, then Device Manager is your go-to tool. Press Win-R, type devmgmt.msc and hit Enter to launch it.

Any obvious problems should immediately be highlighted – look for entries with a yellow exclamation mark or a red cross next to them. Double-click an entry to open its own Properties window where you'll be given a brief summary of the problem under 'Device status' in the General tab. You can also review the device's entry in the system logs via the Events tab.

Some basic issues can be resolved from the General tab. For example, if the device has somehow been disabled, you'll be prompted to click the 'Enable Device' button to restore it **[Image E]**. In most cases, however, you'll see an error code and associated message – for example, 'This device isn't configured correctly. (Code 1)', or 'The drivers for this device are not installed. (Code 28)'.

Some driver issues (codes 14 and 38) can be fixed with a simple

STAY ALERT(ED)

Event Viewer allows you to create alerts that are triggered when specific events occur. This can prove useful for troubleshooting underlying problems as you may find a seemingly unrelated event is triggering the error or get an early warning that something is about to happen. Once you have located the event you wish to monitor, right-click it and choose 'Attach Task to This Event...'

Change the name to something you will recognise in Task Scheduler (see next step), then click Next twice. Neither email nor 'display a message' options work, so leave 'Start a program' selected and click Next. Type 'msg' into the Program/script box, then type * followed by your message (eg. '* Error Alert') into the 'Add Arguments' box. Click Next > Finish > OK.

You may no longer want that alert popping up, hopefully when you have fixed the problem. To remove it, open Task Scheduler – type 'scheduler' into the Search box and click 'Task Scheduler', or press Win-R, type 'control schedtasks' and click OK. Expand Task Scheduler Library > Event Viewer Tasks, right-click the alert and choose Delete then Yes.

reboot, while others that appear to be driver-related can sometimes be resolved by simply removing and reinstalling the device using its current drivers. Close the Properties box, then right-click your malfunctioning device and choose 'Uninstall device'. Once complete, restart your PC – the device should be automatically detected and drivers reinstalled, which you can confirm after restarting by opening Device Manager again.

If the problem persists, right-click the device again and choose 'Update driver' followed by 'Search automatically for updated driver software' to see if a newer driver is available via Windows Update. If no driver is found, check out our tutorial on finding and installing drivers from other sources.

Other errors usually provide some advice on what to do next, but if you're still struggling to fix the problem make a note of the device name and include both it and the error code number in a web search to see if you can find additional help – for example, 'AMD USB 3.10 eXtensible Host Controller code 12.'

More Device Manager fixes

A hardware device's Properties tab contains other useful information that may help you troubleshoot the problem. The Driver tab provides detailed information about the installed driver such as its date, version, and where it came from.

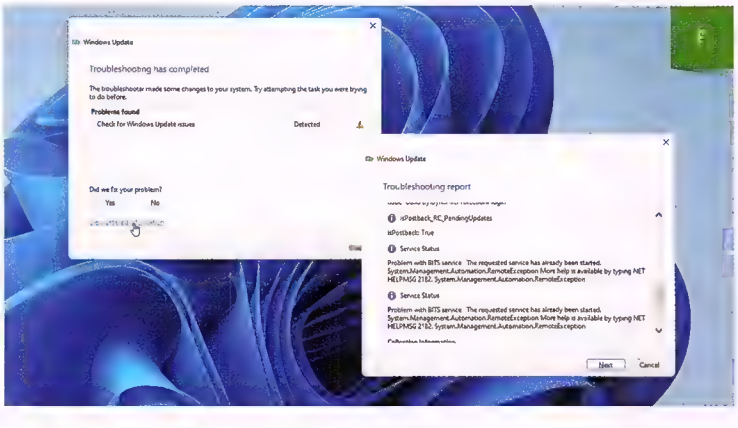
Those listing Microsoft as a provider and Windows as the digital signer are WHQL-certified drivers available through Windows Update. These are the best choice for prioritising stability over performance, but if you suspect a recent driver update is the cause of your problem, try the 'Roll Back Driver' button. If it's grayed out, you're either using your manufacturer's drivers or the earliest version in its WHQL-certified form.

The Details tab lets you examine various parts of the hardware device in more detail. Many properties listed are beyond most people's skill set, but you may get some useful info from properties like 'Device description' or 'Installation date'.

Look out for additional tabs depending on the type of device. For example, input devices like keyboards and mice have a 'Power Management tab' where you might be able to resolve issues with your computer unexpectedly waking up when put to sleep. Hard drives come with a Policies tab where you can optimise the drive for quick removal or better performance. Look out too for a Volumes tab where clicking Populate can help you match a physical drive to its Windows' drive letter.

Access Windows troubleshooters

Windows provides a series of troubleshooters spanning a wide set of issues. In Windows 11, they're configured to pop up when Windows detects specific issues – each troubleshooter is designed to search for specific issues within a set topic (for example, Internet Connections or Playing Audio), then offer to perform recommended fixes to try and fix the problem. It's then a case of following the wizard and answering any specific questions. If you see an 'Advanced' option, it's worth expanding this to see if there's any additional configuration available, such as an option to run the troubleshooter with administrator privileges for deeper access to the system.



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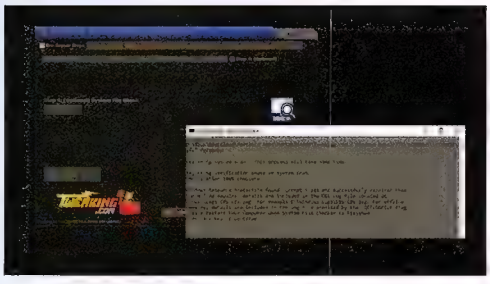


TEST AND REPAIR

Windows is packed full of tools for testing and repairing different parts of your system but they are a bind to access manually. This is where Tweaking.com Windows Repair Tool Free (**www.tweaking.com**) comes to the rescue. Once installed or downloaded in portable form to your USB disk, you can run a series of tests and examine its comprehensive set of repair tools that can fix most problems.

The tool is best run in Safe mode – open the program and click 'Reboot to Safe Mode'. Follow the prompts, selecting 'Safe mode with Networking'. Run through the pre-repair steps and if problems are found and fixed, reboot when prompted. If the problem isn't resolved, reboot into Safe mode and run Windows Repair again, this time focusing on its Repairs – Main tab. The tool offers over 30 repairs, with categories such as malware cleanup and permissions only.

Find out more about a repair using the Repair Info tab, then simply tick one or more repairs you'd like to run and click 'Start Repairs'. When they are done, reboot your PC to see whether the repairs have had the desired effect.

When the troubleshooter finishes, it will provide a summary of what, if anything, it has discovered and tell you if it has attempted fixes. It's rather vague, so click 'View detailed information' to view the report in full. The dialog's a little small, so scroll down and click 'Detection details' next to 'Issues found' where you may see additional information **[Image F]** that, if the troubleshooter fails to fix your problem, can be added to your web search for possible help.

You don't need to wait for Windows to prompt you to run a troubleshooter – open Settings and navigate to System > Troubleshoot where you'll be able to change Windows' behavior regarding recommending troubleshooters. More crucially, you'll also be able to access a list of troubleshooters by clicking 'Other trouble-shooters'. The dirty secret is that this isn't a comprehensive list – type 'troubleshoot' into the 'Find a setting' box and you'll uncover others, such as compatibility troubleshooters for older programs and Windows Firewall. ■

WINDOWS

3D map effect with GIMP

Expand your creative talents. Sam Lewis has top tips for the fabulous, free Gimp.

YOU'LL NEED
GIMP 2.1
OS: Windows 7 or newer

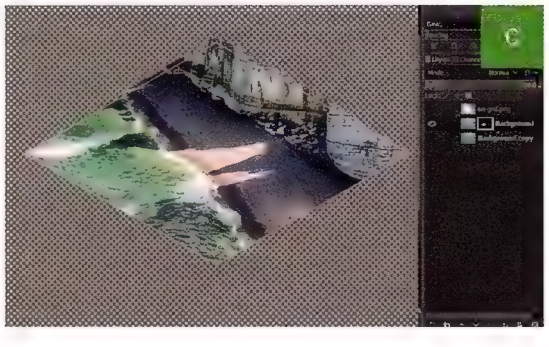
When using a photo manipulation application such as Adobe Photoshop or GIMP, there are many more possibilities than you may initially realise. Plenty of these programs can be used in various ways to create unique pieces of artwork. In this tutorial, we will create isometric 3D art using GIMP. This technique can be transferred onto all sorts of different media and can be used to emphasise a particular place or subject. Learning as many skills as possible can enable you to broaden your creativity by applying them to new forms.

We will be using an image from Unsplash, which is of a skewed piece of land, taken from an angle and not a birdseye view. This will help later on in the tutorial to create a 3D effect. In particular, we've chosen an image of the coastline at Étretat in France by Allyson Beaucourt and we will use part of this image to create our isometric cutout. Of course, you can use any image you like, as long as you have the license for it. Unsplash and other license-free image sites are great for practicing and getting to grips with these skills.

Working off-grid

Once you're happy with your image, open it up in GIMP, either through the file selection method, copy and paste, drag or drop, or right-clicking on the image and opening with GIMP. Yep, there are plenty of different ways to get started.

After this, rename the image to suit your work, duplicate this unchanged image and then lock and hide that layer. It's always important to have a spare duplicate in case we need to go back and make some changes.



Next, we need to download an isometric grid from an image browser to use to draw our cutout shape. Once it's been downloaded, head to File, Open as layer and then click the file. Bring this over your image and reduce the opacity so that you can see your original through the isometric grid. This is now where we will choose the section we want to emphasise. **[Image A]**

Take the right path

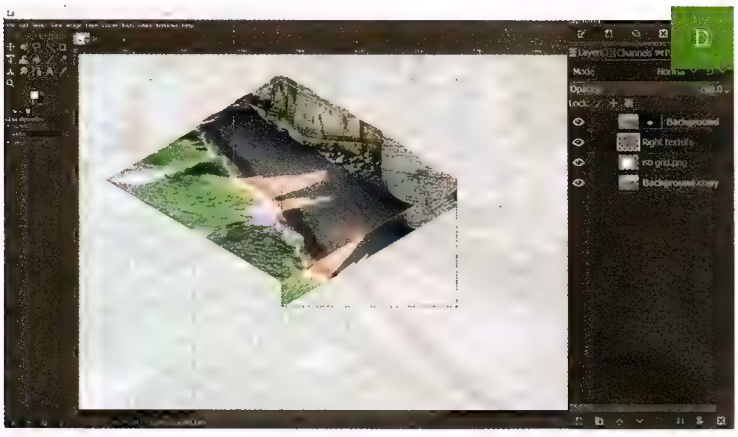
So you've decided where you want to cut, now we need to use the pen tool to draw this shape. Create an equal isometric square similar to the one we've created in our example using this grid as a guide to follow. Make sure the isometric grid layer is locked and that you have the main background layer selected **[Image B]**.

To create this, use the paths tool on the left-hand side of GIMP's default workspace. Click over the isometric grid to create a shape as we have. To close your path, hold CTRL and click once you've finished.

Next, head to the paths panel, which is next to the layers panel, and select the eye icon to see this path. We can then go back to the Layer panel and use the move tool to fine-tune the part of the image you wish to emphasise using the 3D effect. Drag the image along until you're happy with what is in your created shape.

Add some texture

Once the placement has been chosen, we need to once again return to the paths panel and right-click on the path. From the pop-up window, choose 'path to selection' and then hide this path



layer and go back to the standard layers. On your main layer, right-click and select 'Add layer mask'. This will open another panel – in here, choose 'Selection' and then click add.

After this, hide the dotted lines by going into the Select menu at the top and choosing 'none'. We can then hide all the remaining layers other than the main layer which we have just cut our isometric shape from **[Image C]**.

Here, we want to give both the top left and top right-hand sides of the shape a texture. To do this, select the mask thumbnail in the icon, and using the brush tool with the white colour selected, we can draw a rough edge to these sides of the shape. This will give a natural edge to our 3D shape.

3d, or not 3D

Now we have the majority of the shape done, we can start to add the 3D sides of the shape. We need to use texture from the existing image to create this and the isometric grid once more. Using the original duplicate layer, we take some of the sand and rock from that layer to form a new layer.

Make sure you have the rectangle tool selected, draw a rectangle that covers both of these textures, and then copy and paste this. It will create a pasted layer. Again, when creating new layers, name these accordingly to your document. We're aiming to take a snippet that can match the side of the 3D shape we already have like in our example **[Image D]**.

After that, make sure the isometric grid layer, the original image, and the new texture layer are visible. Bring the isometric image to the bottom and then select the texture layer. In the transform tools, select the perspective tool and morph it to create one of the sides to the 3D isometric image as shown.

Now apply the same method to the other side of the shape. On this side, we only have some of the sea visible so we are just going to use a crop from the sea to create this edge making life a little easier.

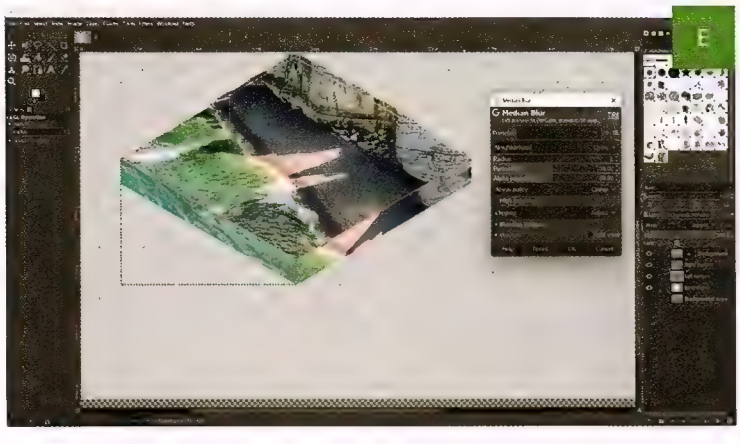
It's all a blur

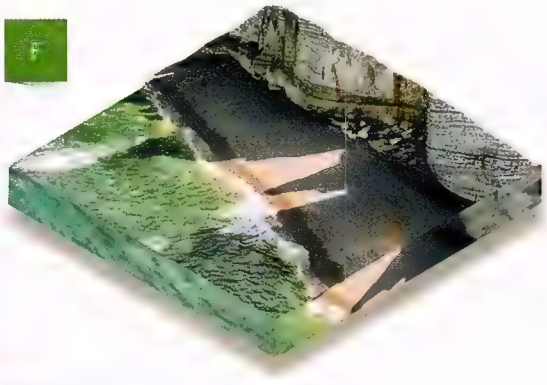
Now, add a median blur to the right and left texture edge layers. Head to filters, then blur, and median blur when selecting a layer. Every image will need different levels of blur, so play with the toggles until you're happy. Now, let's add a shadow. **[Image E]**

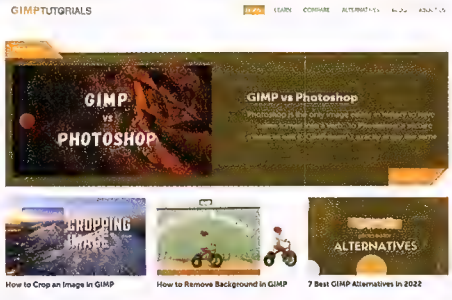
In the layer panel, have the layers you want visible, then right-click on any active layer and select 'new from visible'. This will create a new layer from all the viewable layers on your panel.

Make sure this layer is active, go to filters, light, and shadow, and select 'drop shadow legacy'. Set the X offset to 5, the Y offset to 60, and the blur radius to 50. Also, make sure the colour is black, opacity is 60, and that the 'allow resizing' box is unchecked, then hit OK **[Image F]**. This will create a blur around the image.

Finally, create a white background layer and bring this all the way to the bottom with only this and the new visible layer selected... and we're done! ■







GIMP PLUGINS

By default, GIMP has a decent selection of tools, brushes, and textures available but this can always be improved. Plugins are a great way of boosting your arsenal and your creativity, giving you more tools to play around with. A quick Google search will give you a huge variety of different plugins to try. If you're thinking of a tool that you may need, it probably already exists, so it's worth researching before getting deep into a new project – these plugins can improve your workflow and save precious time designing. A good place to start is by heading to thegimptutorials.com. Here, you can learn more information about plugins, how to install them, and examples of great plugins to try out.

WINDOWS

Turn a monitor into a digital dashboard

Anthony Spadafora turns an unused monitor into an information delight.

YOU'LL NEED
- An old or cheap monitor
- A monitor wall mount HDMI and Power Cables
- Raspberry Pi 4B or old PC
- DAKboard (www.dakboard.com/site)

Having all the information you need available on one screen can be a great convenience, especially during the work day. Instead of having to pull up separate apps to check the weather, view your calendar, and read the news, you can have everything in one place.

Sure, there are lots of gadgets out there that purport to do this, most notably the Amazon Echo Show 15, but at around $399, it's a lot more expensive than a standard PC monitor, not to mention significantly smaller. But maybe you have an old monitor around that's not being used, or maybe you've been eyeing an upgrade to something bigger or better. In that case, why not repurpose your old monitor into something brand new, using some free software and cheap hardware? Something that will be of great use to you and your family hanging on the wall of your office, your kitchen, or the entrance of your home?

> "First launched in beta back in 2015, DAKboard is a customisable web interface used to display photos, calendars, news, weather, and more."

In our example, we used an old monitor and the free DAKboard dash software. We only had to purchase a wall mount and we could put some old hardware to good use.

Roll your own

First launched in beta back in 2015, DAKboard is a customisable web interface used to display photos, calendars, news, weather, and more. Although the company sells a pre-made wall display that has all of the hardware needed (as do certain other third parties), you can also make your own using off-the-shelf hardware.

If you don't have an old computer lying around, the cheapest way to do this is to buy a Raspberry Pi 3B+ or a Raspberry Pi 4B, which are recommended by DAKboard. Supply chains are getting better for these cheap micro-computers, but you may still have trouble finding one at their recommended retail prices. Expect to pay around $230 for a Raspberry Pi 4B starter kit with everything you need, including power and HDMI cables, microSD card, and case.

As we had plenty of PC equipment around, we decided to use an old mini-PC to get the job done instead. DAKboard supports Windows, in addition to iPads, Android tablets, smart TVs, Amazon Fire TVs, and of course, Raspberry Pi computers. The benefit of using a Raspberry Pi is that it can be tucked behind a monitor pretty easily, and its power draw is much lower than even the smallest of traditional PCs. However, a mini-PC can still be hidden away on a shelf, as we did here.

DAKboard's paid plans allow you to run multiple screens in landscape or portrait modes.

Premium content

Getting DAKboard up and running is a matter of logging into a web interface running in a full-size browser window. The company recommends Chrome, as it tests all the latest features using Google's browser.

One of the main reasons we decided to go with DAKboard over something similar, such as Rainmeter, is that we wanted our setup to be easily portable across devices without having to reconfigure things each time. Just bear in mind that if you're using more than one screen, you'll have to pay for one of DAKboard's subscription levels, which start at US$5 per month.

Another nice thing about DAKboard is its flexibility. Although the free plan limits you to one screen and predefined layouts, the paid plans let you configure multiple screens in either portrait or landscape. We set up both a landscape and portrait screen, though it's easy to switch between the two as each DAKboard (even the free one) has its own private URL. This way, you can add them to your bookmarks and show off your digital dashboard with one click.

Left to your own devices

We were also pleasantly surprised when testing out a landscape DAKboard, as it automatically scales for larger screens, including an ultrawide monitor. However, we did have to change

Landscape or portrait – choose your layout.

its resolution manually when trying it out on other devices, such as the Chromebook Duet 3 or an Android tablet.

Even with the free plan, you can still make lots of tweaks to the appearance and there are integrations for a variety of photo hosting sites, such as Flickr and Apple Photos, plus you can add your Google Calendar. You can also add an RSS feed showing all the latest stories from your favourite websites, such as our sister publications, *TechRadar* and *Tom's Guide*, where you'll find RSS links at the top of the homepage next to the social icons.

If you want more integrations, you'll have to upgrade to a paid plan. That's what we did as we really wanted our digital dashboard to be shown in portrait mode without having to change any settings on the monitor itself.

Integrating into the community

Besides giving you more integrations, the cheapest paid plan (Essential, costing US$5/month) also unlocks an advanced editor. Those familiar with any of the most common website builders, such as Wix, WordPress, or Squarespace will feel right at home.

Much like those website builders, DAKboard's block-based editor allows you to drag and arrange blocks for different tools and integrations to configure your digital dashboard. From stock quotes to Slack messages, there are a wide variety of blocks you can add to your screens so you have all the information you need throughout your day available at a glance.

As the Essential plan gives you two custom screens to work with, you could potentially configure one for your work and another for personal matters and switch between the two throughout the day. Likewise, if you have multiple devices, for example, a smart TV and a monitor, you can have both screens on at the same time.

DAKboard running on a tablet

In our case, we now have a wall-mounted monitor showing a digital dashboard in portrait mode in the home office, plus a repurposed old Android tablet to show calendars and the weather when working elsewhere in the house.

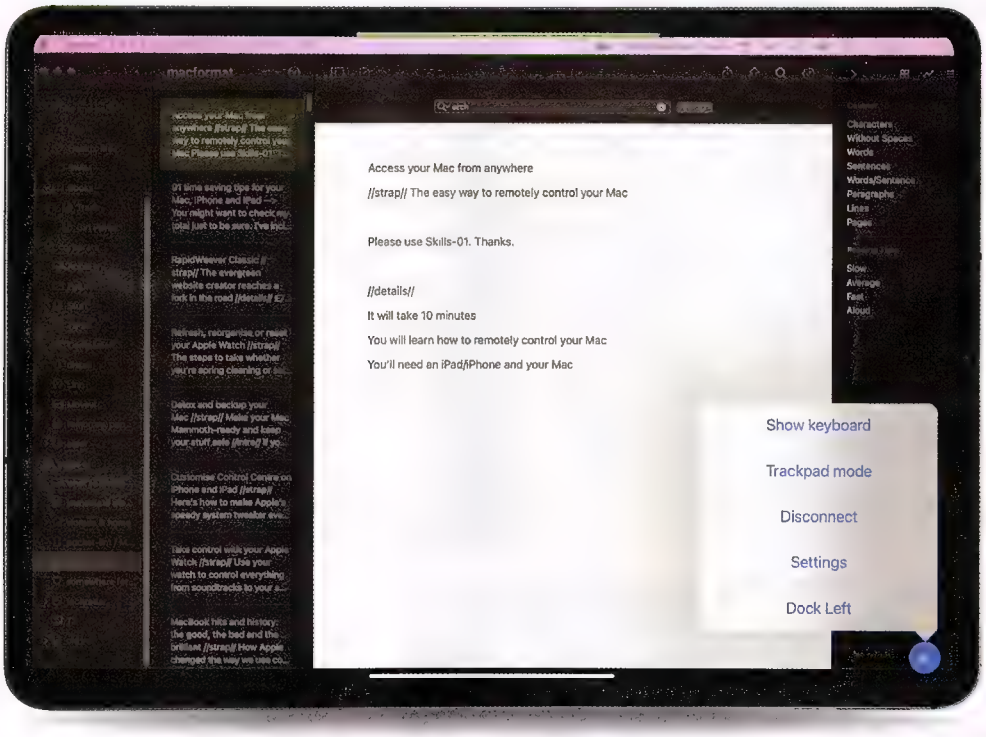
Although the digital dashboard has only been up on the home office wall for a few days, it has already been of constant assistance, really helping us to stay on top of things throughout the day.

As for the future, we're looking forward to perhaps creating a separate screen with social media feeds to help stay up to date with family and friends. Or possibly one that displays our favourite pictures to remind us of what's most important in life. ■

MAC OS

Access your Mac anywhere

Learn how to control your Mac via your iPad, iPhone or another Mac.


Access your Mac from anywhere
//strap// The easy way to remotely control your Mac
Please use Skills-01. Thanks.
//details//
It will take 10 minutes
You will learn how to remotely control your Mac
You'll need an iPad/iPhone and your Mac
Show keyboard
Trackpad mode
Disconnect
Settings
Dock Left

IT WILL TAKE
10 minutes

YOU WILL LEARN
How to remotely control your Mac

YOU'LL NEED
You'll need an iPad/iPhone and your Mac

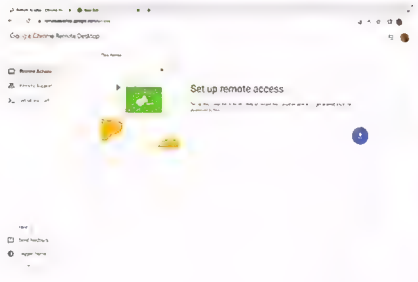
Picture the scene – you're miles away from your Mac, and you need to access something on it that isn't stored in iCloud or another cloud storage service. What to do? If you have remote-access software, you can connect via your iPad, iPhone or another Mac to access and edit files remotely.

There's no shortage of remote-access options for Macs, and they range from built-in (but a little techy) SSH access in macOS's System Preferences > Sharing > Remote Login to dedicated remote-access solutions, such as MSP360, Splashtop and others. However, one of the simplest options is completely free: Google Chrome Remote Desktop.

Install the Remote Desktop extension in the Chrome web browser on your Mac, and you will be able to access and control your machine from your iPhone, iPad or any internet-connected computer that runs Chrome. As we'll discover, once you're set up, the Chrome Remote Desktop is simple and very effective indeed.

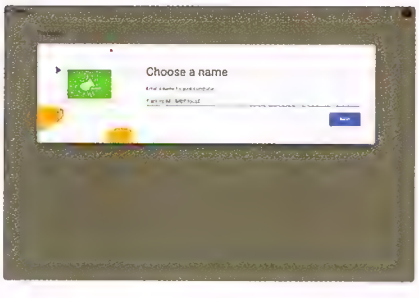
Carrie Marshall

HOW TO ACCESS YOUR MAC WITH CHROME REMOTE DESKTOP



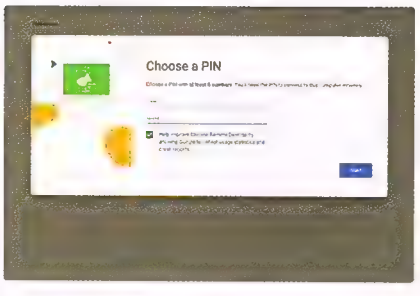
1 GET THE EXTENSION

To use Chrome Remote Desktop, first install the Google Chrome browser and then use it to visit remotedesktop.google.com/access. You should now see the screen above: click on the blue download button to continue.



2 NAME YOUR MAC

In order to connect to your Mac it'll need to have a new name. You can stick with the suggested name here (which is what we'll do), or you can give your Mac a different name. This will be what appears in your other devices' apps.



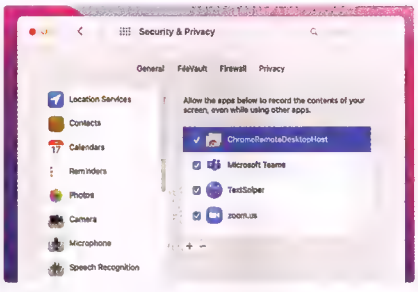
3 PIN PROTECT IT

You now need to create a PIN, which needs to be at least six digits long and shouldn't be easily guessable – so '123456' is a no-no. This, in conjunction with your Google account, will prevent other people accessing your Mac.

CONTINUED... ACCESS YOUR MAC REMOTELY

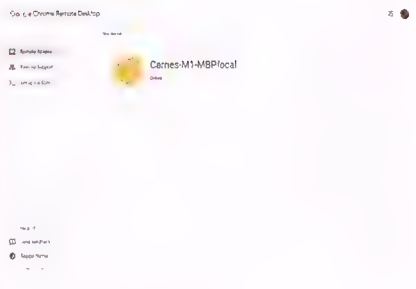
4 GIVE GOOGLE ACCESS

You'll now be asked to give appropriate system access to Google's app, and it'll tell you exactly what you need to do. First of all, we need to enable ChromeRemoteDesktopHost in the System Preferences Accessibility panel.



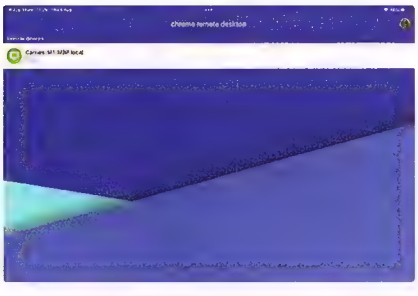
5 ENABLE SCREEN CAPTURE

The next thing Chrome will ask you to do is to tick the button next to ChromeRemoteDesktopHost in System Preference's screen-recording settings. This is so Chrome can stream your Mac's display to your other devices.



6 SEE YOUR STATUS

Once you've done all that, you'll be able to return to the Chrome browser where you should see something like the above (but with your Mac's name in the headline instead of ours). If it says 'online', you're good to go.



7 GET THE APP

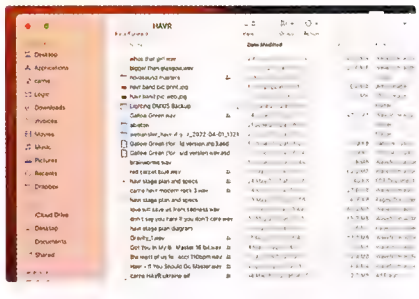
If you connect from another Mac, you just need Chrome with the Remote Desktop extension, but for iOS you'll have to install Chrome Remote Desktop from the App Store. Use the same Google account to log in as you did with Chrome.

8 PICK YOUR MAC

Tap on the Mac you want to use – right now it's the only on-screen option, but the app can store multiple Mac and PC details. After a few seconds you should see your Mac desktop. Tap the blue icon at the bottom right.

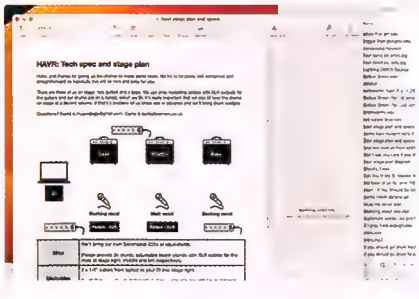
9 SET THE SIZE

If you don't tick Resize Desktop To Fit in the app's Settings, you may find your touch control (or trackpad, if you choose that option) isn't happening in the right place. We've also found that multiple monitor setups can be tricky.



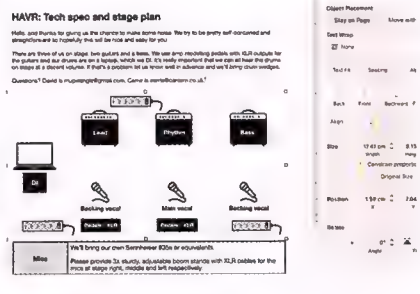
10 MOVE AROUND

The app uses touch mode by default, enabling you to pinch and swipe to zoom and move. Here we've double-tapped on a Desktop folder to open it in the Finder. Now, let's open a document on the Mac from our remote iPad.



11 OPEN AN APP

Above, we've selected a Pages document, and you'll see it's opened up normally in the app – we've got our toolbars and all the bits of the document present and correct. We're now controlling Pages with our iPad.



12 GET THINGS DONE

While we're viewing and interacting with this document on an iPad, the app is running on our Mac and the file is on that Mac's SSD. Anything we could do on our Mac, we can now do from our iPad. ■

LINUX

Set up your smart phone as a webcam

Nick Peers reveals how to convert your mobile devices into cameras you can use while chatting in Linux.

QUICK TIP!
Should you wish to remove DroidCam at any point, do so with the following command: **sudo /opt/droidcam-uninstall.**

Need a mobile internet protocol (IP) camera, but don't have the funds to purchase one? Want to make better use of your mobile devices – even the old ones that are gathering dust at the top of the cupboard in the spare room? Then DroidCam is the answer. This tool enables you to link your mobile to your PC so you can access its video camera as a webcam on your desktop. Whether using it to chat with others or even as an additional camera for video creatives (see the box, facing page), DroidCam has you covered.

"DroidCam exists in two parts: the mobile app that you download from Google Play or Apple's App Store, and the client software on your PC."

Installation

DroidCam exists in two parts: the mobile app that you download from Google Play or Apple's App Store, and the client software on your PC. This installs a set of drivers – Video4Linux and ALSA loopback – and provides the connection to your mobile.

The 64-bit version of DroidCam is available to install as a binary. Open a Terminal window and then issue the following commands:

```
$ cd /tmp/
$ wget -O droidcam_latest.zip https://files.dev47apps.net/linux/droidcam_1.8.2.zip
$ unzip droidcam_latest.zip -d droidcam
$ cd droidcam && sudo ./install-client
```

DroidCam uses a system tray indicator icon, which requires a dependency that's been removed from the latest builds of Ubuntu, Debian and Fedora. Ubuntu users can restore it with:

```
$ sudo apt update && sudo apt install libappindicator3-1
```

To finish the job, we need to install a loopback module. Just type the following:

```
$ sudo apt install linux-headers-`uname -r` gcc make
$ sudo ./install-video
$ lsmod | grep v4l2loopback_dc
```

The final command should output confirmation that the loopback module is running.

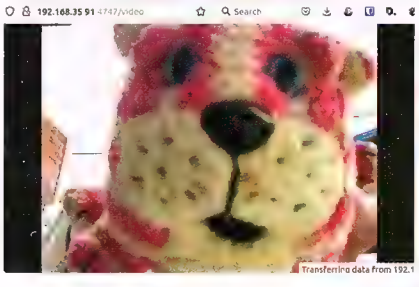
Set up your webcam

Open DroidCam on your phone and run through the quick-start wizard. The developers recommend you only use it for video, so feel free to block access to the microphone when prompted. Make a note of the Wi-Fi IP and Port numbers, then open the PC version of DroidCam from the launcher. A pop-up window will appear. Leave Wi-Fi/LAN selected, enter the Wi-Fi IP address you recorded into the Phone IP box, verify the port numbers (4747) match, and finally click Connect.

After a short pause, the DroidCam app should start streaming using your phone's rear camera – you'll find the control to switch cameras in the bottom left-hand corner of the screen along with EV (exposure) and AWB (auto white balance) buttons. These provide you with sliders to fine-tune the lighting and colour balance.

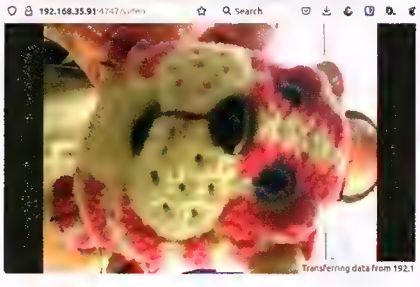
You'll also find similar controls – EV and AWB – in the Linux program, although they work in a slightly different way as you'll see shortly. For now, tap the Settings button in the mobile app to access controls such as preventing the screen from automatically dimming and changing the default port that DroidCam works on. You can also tweak camera settings from here, including quality, camera position (which camera

HOW TO... USE YOUR PHONE AS AN IP CAMERA



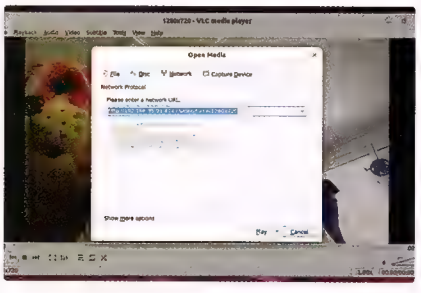
1 CONNECT VIA IP

Make sure *DroidCam* is open on your phone before opening your web browser and typing **http://<ip>:4747/video/** into the Address bar (substitute <ip> with the IP address displayed on the phone). You should see the video feed appear.



2 CORRECT ASPECT RATIO

The video will display a mirror image of that shown on the phone. It also assumes that your mobile is set to display in landscape orientation, so if the image appears on its side, you'll need to flip your phone to landscape view.



3 DESKTOP ACCESS

You can also access this feed via programs that support IP cameras – for example, *VLC*. In *VLC*, select Media>Open Network Stream. Type the same URL you entered in step one into the network URL box and click Play.

to use by default), and a handy Limit FPS (frames per second) option to reduce bandwidth and power usage.

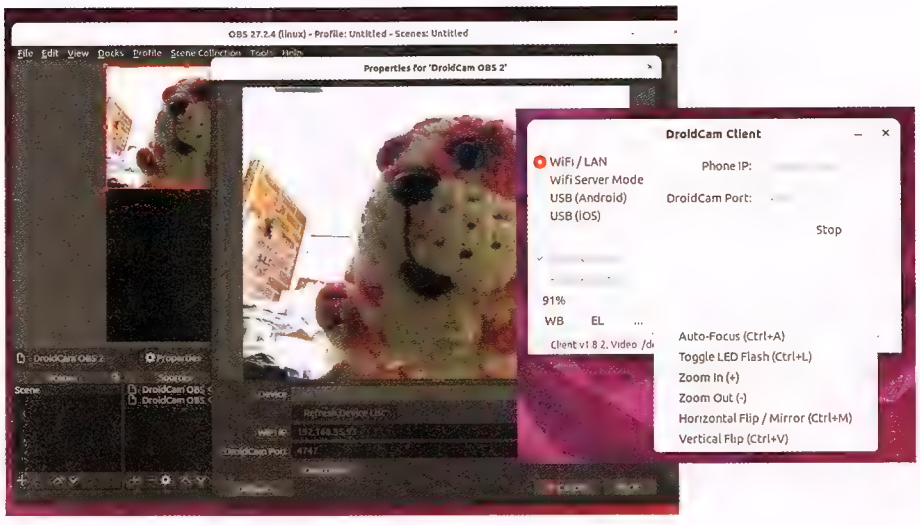
For most people, the defaults should be fine, but if you're connected to power or have a suitably fast connection then you may want to improve quality and FPS. Conversely, if you're on a slow connection, try reducing the quality.

Make a call

Once you've configured DroidCam on your phone and positioned the camera, turn your attention back to the Linux client. The WB button enables you to choose different preset lighting effects, with options ranging from incandescent and warm fluorescent to daylight and shade. EL is an option to lock the exposure control while the '...' button reveals further options, including a zoom control, support for flipping the screen and toggling both automatic focus and (if applicable) the LED light on your phone. Only the zoom controls work in the free version.

To hide the client from view, click the minimise button – if you've not already spotted it, you'll see the DroidCam icon in your menu bar – just click this and choose Show to bring the controls back.

Now switch to any Linux program with support for webcams. Here you should find that DroidCam is now an option alongside any other installed webcams. Explore the chat app's settings to see if you can set DroidCam as the default camera for messaging (Signal users should select File>Preferences>Calls, for example).



Once installed, the Linux app is used to gain access to your phone camera. You can also tweak various settings. If you install the OBS Studio plugin then you can also use your mobile phones as additional cameras in your creative video projects.

Free versus paid

DroidCam exists in two versions: free and Pro. If you're an iOS user, you simply upgrade to Pro for £5.99 within your existing DroidCam app; if you're an Android user, you'll need to purchase DroidCamX ($5.49) separately. The main advantage of upgrading to Pro is to unlock support for HD streaming. In addition, DroidCam iOS users will unlock access to all settings (basically those greyed out in the free version) as well as those on the PC client. After unlocking HD support, you'll need to update the loopback module to stream at a higher resolution. Visit **www.dev47apps.com/droidcam/linux** for instructions on how to do so.

Other connection types

If your Wi-Fi connection is too flaky, you can also connect to your mobile via USB. Connect the cable to your PC – iOS users will be prompted to trust the device – and then choose the appropriate USB option within the DroidCam app before clicking Connect. This provides a much more stable connection than Wi-Fi, but of course ties the mobile to the vicinity of your PC.

You can also use DroidCam as a straightforward IP camera. In this mode, you don't even need to install the software or have it running on your PC. The step-by-step guide (opposite) reveals all you need to know. Finally, you'll notice a fourth connection option is available: Wi-Fi Server Mode. This only works with the DroidCamX Android app, and reverses the connection, enabling you to stream your PC's webcam (video only) to your phone. Visit **www.dev47apps.com/droidcam/connect** to find out more about these and other connection options. ■

"The main advantage of upgrading to Pro is to unlock support for HD streaming."

LINK DROIDCAM TO OBS STUDIO

You can also use DroidCam to make it possible for you to deploy your mobile as a camera within OBS Studio. First, download the OBS DroidCam plugin in zip format from **www.dev47apps.com/obs**. Once done, extract the files into a single folder inside your **Downloads** folder, then navigate to that folder in Terminal (such as **cd Downloads/plugin**) and issue the following command:

```
$ ./install.sh
```

This will create a **plugins** folder and copy the OBS Droidcam plugin into it. Now open OBS Studio and when you come to open a source, you'll see OBS Droidcam is an option. Select this, click OK and enter your mobile's Wi-Fi IP into the relevant box and click Activate (if the button isn't visible then you'll need to scroll down).

You can set up multiple mobiles as cameras – just add extra OBS Droidcam cameras and point them towards your other devices' IP addresses. Note, the iOS DroidCam app includes OBS Studio support; Android users will need to install a separate app (DroidCam OBS).

Free users are restricted to standard definition video – iOS users unlock HD support by buying a Pro licence for the main DroidCam app; Android users must pay $9.99 to unlock DroidCam OBS, but gain extra benefits including a remote camera control dock.

RASPBERRY PI

Stream live data to custom web pages

Les Pounder takes the latest and smallest Raspberry Pi with Wi-Fi and turns it into a $10 web server with live sensor data.

YOU'LL NEED THIS

- Raspberry Pi Pico W
- DHT11 temperature sensor
- 3 x MtoM jumper wires
- Half breadboard
- Internet connection
- A computer
- Get the code from: **https://github.com/lesp/LXFPicoWDHT11/archive/refs/heads/main.zip**

This simple project is running from a cheap microcontroller that's serving live sensor data to a custom web page.

The $10 Raspberry Pi Pico W has caused quite a stir, offering Wi-Fi for just a couple of extra dollars. What was usually the domain of the Raspberry Pi Zero W, or other Wi-Fi microcontrollers such as the ESP32 and ESP8266, is now seeing the powerful RP2040-powered board muscle its way in.

Wi-Fi connectivity provides an easy means to send data, be it to remote devices, or in this case to serve data using a Python-powered HTML server. In this tutorial we'll post live sensor data, taken using a DHT11 temperature sensor, to our own web page that's hosted on a Raspberry Pi Pico W.

Pins matter

The circuit for this build only comprises three wires that connect the DHT11 sensor to the Pico W's GPIO via a breadboard. Looking face-on to the DHT11 (the blue plastic cage) we have VCC (power), Data, No connect, and GND. Place the DHT11 into a breadboard, but make sure that it's not overlapping any pins with the Pico W. Connect GND from the DHT11 to any GND pin on the Pico W. Connect VCC to 3V3, pin 36. Finally, connect data to GP2, which is pin 4. Refer to the circuit diagram in the download file for a high-resolution image.

Pico Python

Our Pi Pico W needs the latest version of MicroPython. But we have to use a version specifically created for the Pico W. Visit the official Raspberry Pi Pico MicroPython page (**tinyurl.com/APC513micro**) and download the **UF2** file for Raspberry Pi Pico W.

Holding down the BOOTSEL button on the Pico W, connect the Pico W to your computer using a micro USB lead. Release the BOOTSEL button and a new drive, **RPI-RP2** will appear. Copy the downloaded **UF2** file to this drive and the Pico W will reboot.

> "In this tutorial we'll post live sensor data, taken using a DHT11 temperature sensor, to our own web page that's hosted on a Raspberry Pi Pico W."

Download the latest version of Thonny for your OS (**https://thonny.org**) and open *Thonny*. Under Tools, click Options and in the new dialog select Interpreter. Set the interpreter to MicroPython (Raspberry Pi Pico) and set the port to autodetect. If the port isn't autodetected, it can be manually selected. Click OK.

Look to Thonny's toolbar and you'll see a red stop sign. Click this to reset the connection to the Pico W. It can also be used to stop any running code.

In a blank file first import four modules of code. These four modules will handle the GPIO, network socket connections, Wi-Fi, and accessing the DHT11 sensor.

```
import machine
import socket
import network
import dht
```

Here we create the HTML for the page. It's saved to an object: **html**. Our first step is to create the HTML head, where we shall set the title of the webpage, and set the page to auto-refresh every 30 seconds.

```
<html>
  <head> <title>Raspberry Pi Pico W Temperature Sensor</title> <meta http-equiv=Refresh content=30></head>
```

Next we create the body, where the structure for the page is created. We create a div, using Bootstrap's "card" format.

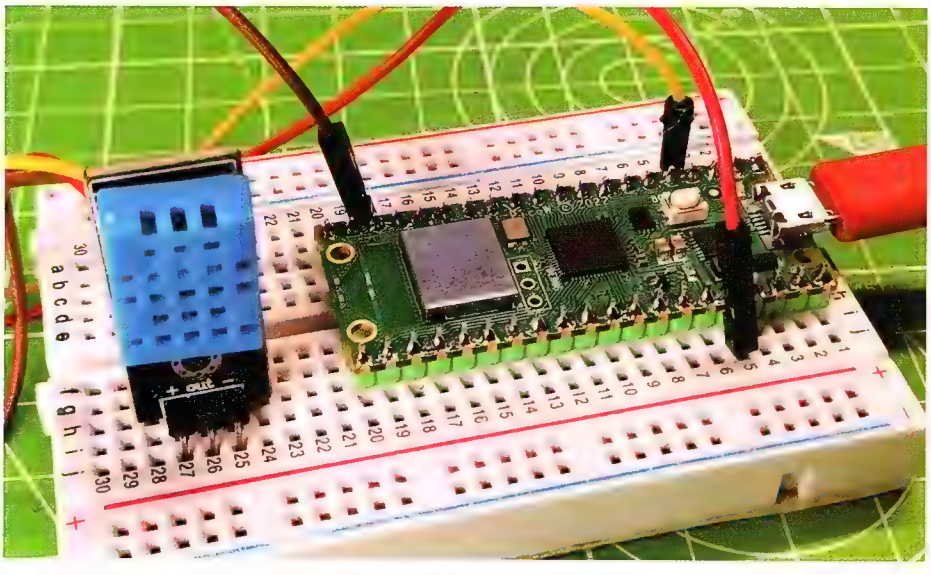
```
    <body>
    <div class="card" style="width: 18rem;">
```

Inside the **card** div we place an image. Note that this has to be an image from a remote site, not one hosted on the Pico W. Best practice would be to use an image that you have permission to use, and host it either on your own server or GitHub repository. We've also added alt text to explain the image:

```
    <img src="HTTPS LINK TO IMAGE" alt="Temperature Sensor Icon">
```

The next part of the card is its body. Here we set the title to "Live Sensor Data" and then use two paragraphs of text to represent the temperature and humidity. The {} will pull data from our sensor readings and drop it into the HTML.

```
    <div class="card-body">
      <h5 class="card-title">Live Sensor Data</h5>
```



```
    <p class="card-text">{} degrees
Celsius</a>
    <p class="card-text">{} %
Humidity</a>
```

We now close the two open divs, and close the body of the HTML document:

```
    </div>
    </div>
    </body>
```

Finally, for the HTML portion of the code, we link to Bootstrap's CDN (Content Delivery Network) and access the latest version of its CSS. This will provide the cool formatting for our page. Lastly, we close the HTML section of code:

```
    <link href="https://cdn.jsdelivr.net/
npm/bootstrap@5.2.0/dist/css/
bootstrap.min.css" rel="stylesheet"
integrity="sha384-
gH2yIJqKdNHPEq0n4Mqa/
HGKIhSkIHeL5AyhkYV8i59U5AR6csBv
ApHHNl/vI1Bx"
crossorigin="anonymous">
    </html>
    """
```

Next we create an object, **sensor**, to connect our code to the DHT11 sensor connected on GP2.

```
    sensor = dht.DHT11(machine.Pin(2))
```

To connect to Wi-Fi we first create an object, **wlan**, to control the Wi-Fi chip. We then set this chip to active:

```
    wlan = network.WLAN(network.
STA_IF)
    wlan.active(True)
```

Using our Wi-Fi access point SSID and password we then connect:

```
    wlan.connect("YOUR
SSID","PASSWORD")
```

We now move into the section where we set up our sockets, which will listen for any incoming connection:

```
    addr = socket.getaddrinfo('0.0.0.0',
80)[0][-1]
    s = socket.socket()
    s.bind(addr)
    s.listen(1)
```

Inside of a loop we set the socket to accept a connection, then create a file that will be our HTML page:

```
    while True:
      cl, addr = s.accept()
      cl_file = cl.makefile('rwb', 0)
```

We read the lines that make up the HTML page. If there are any line breaks our carriage returns, then the loop will break:

```
      while True:
        line = cl_file.readline()
        if not line or line == b'\r\n':
          break
```

Before we can get sensor data from the DHT11 we need to measure the temperature and humidity. If we skip this line, our sensor won't work.

```
      sensor.measure()
```

Create two variables, **temp** and **humid**, and in each store the current temperature and humidity detected by the DHT11:

```
      temp = sensor.temperature()
      humid = sensor.humidity()
```

We then create an object, response, and use that object to drop the temperature and humidity data into the HTML. These values are placed in the {} that we created in the **card-text** classes inside our HTML code:

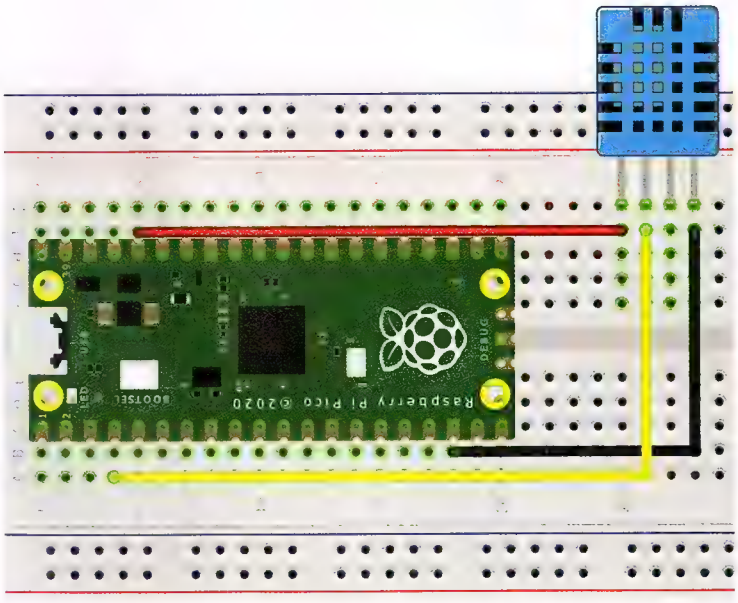
```
      response = html.
format(str(temp),str(humid))
```

Finally we ensure that our HTML page is compliant with HTTP content types and close the connection. The connection will automatically reestablish itself in 30 seconds, as per the page refresh:

```
      cl.send('HTTP/1.0 200 OK\r\
nContent-type: text/html\r\n\r\n')
      cl.send(reponse)
      cl.close()
```

Save the code as **web_temp.py** to your Raspberry Pi Pico W. Click Run to start the code. Find the IP address of your Pico W using your router admin page, or an application such as Fing for Android.

In a browser on another device, go to the IP address and after a few moments you'll see live sensor data, refreshed every 30 seconds. ■



The DHT11 needs only three connections: VCC for 3V voltage, GND, and a data connection that sends temperature and humidity data to the Pico W.

GENIUS TIP!

Sometimes you may need to reset your Pico W, but there isn't a reset button. Just use an extra male to male jumper wire to quickly touch GND and RUN (pin 30) to reset the Pico W.

WHICH SENSOR IS RIGHT FOR YOU?

The ideal temperature sensor for your project depends on what level of accuracy you require. For hobbyists, the DHT11 is more than enough. It can detect between 0 and 50°C temperature readings ±2°C accuracy, and 20-80 per cent humidity readings with five per cent accuracy. We can only take a reading every one second, though.

The DHT22 looks similar to the DHT11, but it can works between -40 and 80°C with an accuracy of ±0.5°C accuracy. It can take 0-100 per cent humidity readings, with two to five per cent accuracy. So for more scientific projects, the DHT22 is the better option.

An even more precise option is an AHT20. This I2C-based device has MicroPython libraries that can be used to simplify working with it. Accuracy is ±0.3°C between -40 and 85°C. Relative humidity range is 0 to 100 per cent with ± two per cent accuracy. The AHT20 can be found on Adafruit and Pimoroni's website for around $10.

If you need a waterproof temperature sensor then consider the DS18B20. It can measure between -55 and 125°C, with 0.5°C accuracy between -10 and +85°C. Obviously there's no humidity sensor, but for temperature measurements then this is a great sensor. It can be used to monitor aquariums or pools or even your bath water.

GAMES

Return to Monkey Island

Worth the three-decade wait?

■ $35.95 | PC, Mac, Switch | returntomonkeyisland.com

apc EDITOR'S CHOICE

The infamously bewildering ending to 1991's *Monkey Island 2: LeChuck's Revenge* left players longing for resolution that subsequent *Monkey Island* games never delivered. Three decades later, and after effectively saying it would likely never happen, key members of the original *Monkey Island* team – including series creator Ron Gilbert – have finally made the game that picks up after the closing moments of *LeChuck's Revenge*.

The mischievous opening confidently asserts that this is the authentic *Monkey Island* experience we've come for: sharp, self-aware, and brilliantly silly. It'll bombard you with gags, but the characters you meet are more than comedic props, and the cunning stream of interwoven puzzles has been modernised to keep the pace up without losing the satisfaction of problem solving. It's a massive success.

The opening prologue whips you through an homage to classic *Monkey Island* moments before thrusting the shambling Threepwood back into his past. Older, tireder, and more challenged by holding his breath, Guybrush has grown in tandem with us, as have *Monkey Island*'s classic characters and locales. Everything is different but familiar in *Return to Monkey Island*, from its characters and narrative to its revised systems for interaction and puzzle

solving. It can temporarily transport you to the '90s, but it isn't stuck there. The story is consistently engrossing and energetic, but spoiling too many details would be beneath LeChuck himself, so I'll keep things general.

After starting out in the first game's Mêlée Island, Guybrush takes to the seas to explore vintage locations such as Monkey Island itself, as well as entirely new lands including the tormented, eerie Terror Island and Brrr Muda, a place inspired by the Viking age. Guybrush is once more in pursuit of Monkey Island's infamous secret. LeChuck, too, has returned to the quest. And both, of course, remain besotted by Elaine Marley.

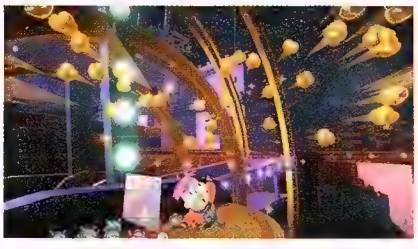
All that is the same, but with the passage of time new figures have risen to power, upsetting the traditions and conventions of Guybrush's world. The old guard of established sea dogs now exist on the fringes, replaced by youthful upstarts eager to reset the rulebook. Even voodoo is no longer in favour, with younger generations favouring 'dark magic' in its place.

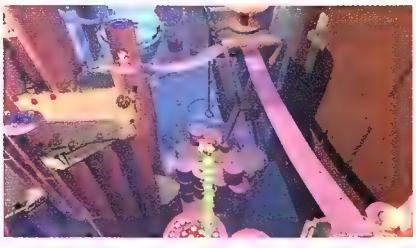
As a *Monkey Island* fan, it's hard for me to imagine what a newcomer's experience would be like. But for those lifelong followers of Guybrush's misadventures, this is as good as it's been for a very long time: funny, captivating, superbly paced, contemporary, and packed with neat ideas and eccentric characters. This is what we've been waiting for since LeChuck and Guybrush emerged from... well. If you know, you know. And if you don't, it's time to go back to the originals.

A return to the *Secret of Monkey Island* series' best that brilliantly modernises the point-and-click form.

Will Freeman

★★★★☆





TINYKIN

Minion management might be shallow, but its platforming shines.

■ $35.95 | PC, PS4, Xbox Cloud Gaming, Switch | tinykingame.com

In *Tinykin*, you play a teensy interstellar traveller who commands a legion of microscopic minions to navigate an oversized environment, and yet it's not the PC-compatible *Pikmin* that I was hoping for.

You play as Milodane, a researcher from a distant planet so far in the future that its human populace doesn't remember where they came from. When Milo activates an experimental transporter to seek humanity's interstellar origins, he isn't just stranded on another world – he shrinks to miniature scale, too. Milo awakens in the House, an abandoned '90s-era home populated by insects who remember the House's original owner as an absent deity, and the Tinykin, a race of enigmatic gremlins who respond to Milo's commands. Your goal's a simple one: using your Tinykin, gather six components from the House's bug societies, and reassemble a machine to teleport home.

Where *Pikmin* is a remixed RTS, Tinykin is a 3D platformer more in line with something like *Banjo Kazooie*, with an even more easygoing vibe.Yes, you're flinging dozens of Tinykin to solve all your problems. But there's no real decision making involved, because there's no way to use them incorrectly. You can't waste or endanger them or accidentally drown a whole squad and feel terrible about yourself. Here *Pikmin* has you considering how to invest your forces, *Tinykin* only expects you to passively gather them.

The House is *Tinykin*'s real star. Its rooms house different sections of bug society, each a self-contained level with its own atmosphere. *Tinykin*'s environmental art gets incredible mileage from the joy of seeing household objects rearranged into insect-scale geography.From fields splayed out across kitchen-floor farmland, to thumbtack furniture in food-tin apartment blocks, Tinykin is dense with visuals. To me, these were the main reward for navigating all its nooks and crannies, because, the actual collectibles you gather in *Tinykin*'s rooms aren't strong motivators.

But even where it stumbles, *Tinykin* delivers the childlike glee of clambering over a small thing that's suddenly very big. That's clearly the goal, and *Tinykin* doesn't overstretch its ambitions.

Inspired by *Pikmin*, *Tinykin* offers up a big little world that manages delight without needing much depth.
Lincoln Carpenter

★★★★☆

BEACH ISLAND DELUXE

Take a mini-break with this 3D platformer.

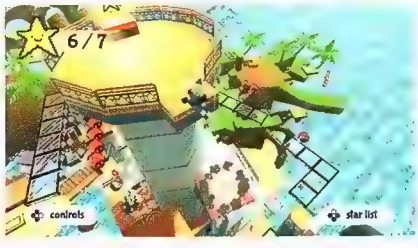
■ Free | PC | bit.ly/BeachIsland

In *Beach Island Deluxe* you play as a bin, wearing Sonic sneakers, sunglasses, and a backwards cap. It's probably a pastiche of '90s mascot design, but you still have to stare at a preposterous bin for the whole game. Thankfully, once you've hopped over the tutorial wall and found your way onto the island proper, you'll be too busy leaping about the place to care. In true 3D Mario style, you're free to head in any number of directions, stumbling onto bite-size platforming courses that will inevitably lead you to a collectible star.

Blocky ruins and metal towers buzz with clockwork hazards and moving platforms, which you have to clear to collect the stars that will open the exit. The best thing is climbing a peak and watching the cogs whir around you – the bomb traps halfway down the tower, and the giant fans puffing away – then leaping off and landing on the ground with nary a scratch. Ooh, I haven't gone there yet – I wonder if there's a star twinkling away down there. So off you trot to bag another object.

Nintendo needn't worry, but this is a good 3D platformer whose bite-size nature leaves me wanting more.
Tom Sykes

★★★½☆



DYNACORE

Room for one more roguelite?

■ Free | PC, browser | prox276.itch.io/dynacore

With their fly-swat default attack, I was put off the hero of *Dynacore* pretty much immediately. It's a Binding of Isaac-style roguelite, but one where you can't reliably get hold of a long-range weapon.

It's miserable because it forces you to close in on enemies, in cramped corridors that are also full of traps. There are traps everywhere, spinning round like the hands of a clock or popping out of walls to scoop chunks of your health.

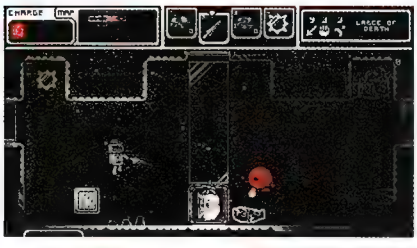
Compounding this is the art style, whose monochrome nature makes it hard to read the level, and the giant, obscuring cursor that forgets it's supposed to be a crosshair.

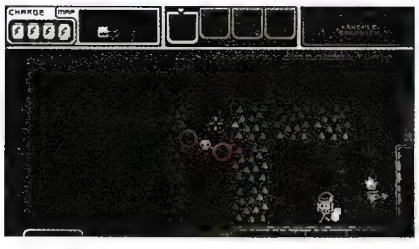
I died a lot in *Dynacore*, but it's worth persisting, because in other ways it's a slickly enjoyable roguelite. It's got the Binding basics down pat: the procedural grid of *Zelda* rooms filled with enemies and occasional pick-ups, and the challenging bosses that will unlock the next level. It feels good to control, with satisfying damage feedback and a hell of a lot of screen shake.

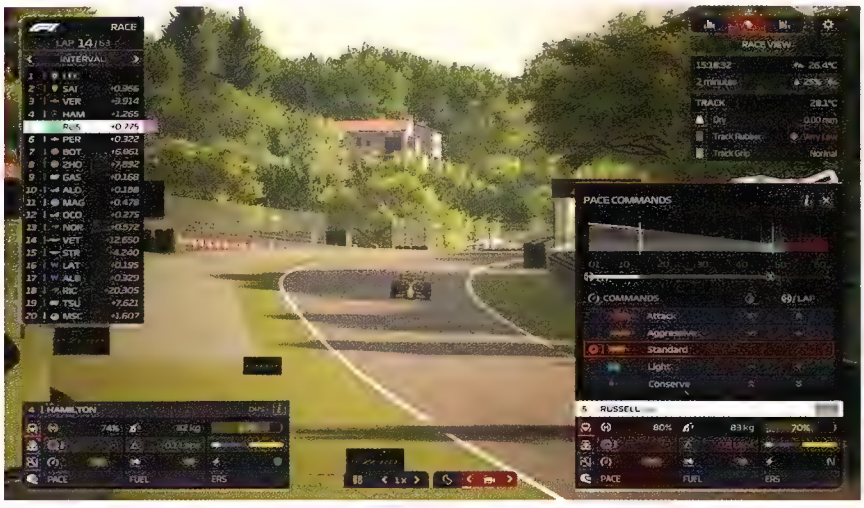
A slick roguelite that can be enjoyable – if you're lucky during a run.

Tom Sykes

★★⯪☆☆







F1 MANAGER 2022

Captures the drama and depth of being a pit boss.

■ $78.95 | PC, XB1/S/X, PS4/5 | f1manager.com

In its debut licensed F1 management sim, Frontier Developments conveys both the palm-drenching reactivity of a Sunday in the sport, and the frantic development race happening in between.

As team boss, you're in charge of everything from signing the drivers who'll sit in your car to the design and manufacture of that car's component parts. Pit crews jump into action on race day at your say-so, and even the amount of money sponsors pay you depends on the promises you make to them before each race weekend.

> "Overseeing a race is the big thing, and it's not a passive experience"

Overseeing a race is the big thing, and it's not a passive experience. There's a lot of micromanagement to involve yourself in – drivers' pace, fuel burn level, ERS deployment, and pit strategy all lay in your hands. When you're managing all of these manually, corner to corner, it feels not unlike driving the car yourself. You're able to strong-arm your drivers through overtakes using these controls, but you can't brute-force a Williams onto the podium using judicious deployment of fuel and ERS alone. For the real head-turning results, you need a bit of luck from the wet weather and some wild crashes.

Crashes, safety cars, and sudden downpours should be the most spectacular and pivotal moments of an F1 manager's season, chances for decisive strategy calls to prevail over outright performance. Alas, crashes aren't really depicted in any detail – cars just stop on track, or run off into the gravel trap. The visual spectacle just isn't here yet. And while wet weather rolls in and soaks the track at a believable rate, the AI is usually a bit too hive minded to produce any interesting scenarios as a result.

Frontier can be proud of its well-judged foundational release in what will certainly become a long-running series. In a perfect world, we'd see cars shatter into carbon fibre splinters when they crashed, and we'd recognise the Verstappens and Ricciardos by their driving styles, not just their liveries. As it is, the fundamentals are all in place, ready to build on.

Tense and involving, if just slightly lacking smarts and spectacle. A firm foundation to build a series on.

Phil Iwaniuk

★★★⯪☆

SOULSTICE

DMC meets Dark Souls in a grungy action adventure.

■ $56.95 | PC, PS5, XBS/X | soulsticegame.com

Where *Devil May Cry* has become more OTT and comedic over the years, *Soulstice* is dark, dour, and drenched in a grim, medieval atmosphere. The story takes a back seat to action and atmosphere, in this apocalyptic, grimdark fantasy setting. It's a thickly ladled mood created by an overbearing soundscape that only lets up during the fast-paced battles, and a desaturated colour palette that makes it difficult to read the world at a glance. I had to squint at my screen multiple times to work out the layout of a scene, or to see the edge of a platform before I fell off the end of it.

The stages in *Soulstice* bounce between two phases. There's the exploration phase, where Briar traverses linear environments, and there are the chunky breakout battles, as creatures leap out of portals to have a go at you. Magical barriers create closed combat arenas, and when you've dispatched every enemy you're graded on your performance: how long you took, the combos you pulled off, how much damage you suffered, etc. There's less emphasis on long-range combat (it's quite a while before you get a bow), and a great deal placed on your ghost companion, who can interrupt enemy attacks at the touch of a button.

There's a lot of platforming in *Soulstice*, and annoyingly never at consistent camera angles. Scenes are framed for style rather than utility much of the time, making it hard to judge the distance of adjacent platforms. I typically use the character's shadow as a guide when 3D games insist on platforming sections, but *Soulstice*'s world is so gloomy that isn't really an option.

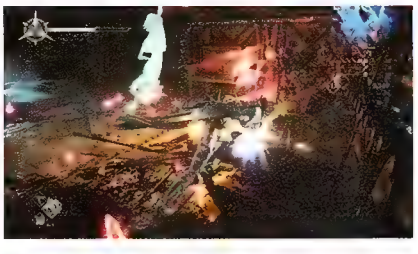
> " What *Soulstice* feels like is a forgotten Xbox 360 action game: a relic from the halcyon days of AA gaming."

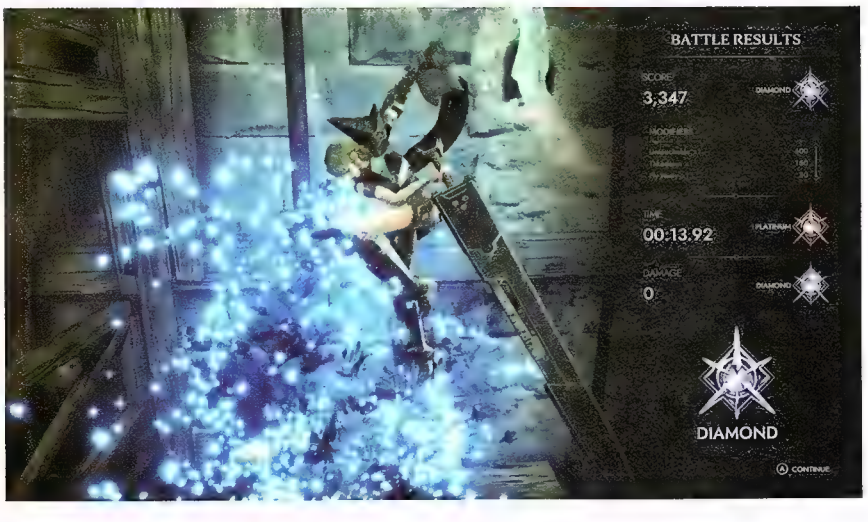
More than anything, what *Soulstice* feels like is a forgotten Xbox 360 action game: a relic from the halcyon days of AA gaming. Games like *Dark Sector* and *Dead to Rights: Retribution* – games that brought some fresh ideas and were decidedly alright at the time, but are maybe less so over a decade down the line.

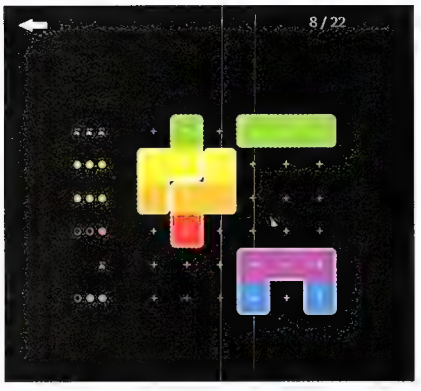
A meaty action game let down by a persistently rubbish camera, a dry story, and a world that's no fun to explore.

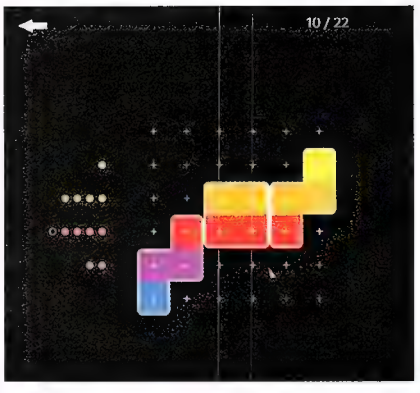
Tom Sykes

★★⯪☆☆









SOMETIMES

Solving emotional puzzles.

■ Free | PC | ludipe.itch.io/sometimes

Here's an unusual puzzle game. I've not played anything quite like it. In each stage you have to place the pieces so that the right number of blocks are present on each line, something you achieve by dragging and rotating each blocky shape. When a shape is at the top of the grid, it will turn green or yellow, and when it's dragged way down to the bottom it will turn a maudlin shade of purple or blue.

So you drag, you rotate, you experiment until you find a solution. The concept is cleverly expanded when blocking squares are introduced – these cancel out one of the blocks on the same line. The game never gets more complex than that, but for me it finds a sweet spot in terms of difficulty.

It's a successful marrying of mechanics and theme, but the brief lines of story are too vague to really add anything. And yet, it reminds me that there are always fresh ideas floating round in the ether.

A cool idea, but is explored in little depth.

Tom Sykes

★★★☆☆

GAME CHANGER

ARMA 3

Samantha Greer's story is for all those map editors who fight boredom.

■ **Release:** September 12, 2013 **Developer:** Bohemia Interactive **Publisher:** In-house **Link:** arma3.com

I don't care much for military simulators. *Arma 3*'s brutal pursuit of realism can forge tense missions and swift deaths but it's typically bogged down in a dedication to military strategy more likely to please hobbyist dads with miniature tank collections. All the love in the world to you guys, no judgement here. It's just not really my bag. Yet, I cannot get enough of *Arma 3*. Like its predecessor I keep returning. But it's not for the campaigns or the multiplayer. It's that wonderful little mission editor.

Going all the way back to *Operation Flashpoint*, I have enjoyed tinkering around in this editor, carving out my own fun. Like a kid with a sandbox full of (suspiciously realistic and co-ordinated) army men, I have spent years throwing together my own little battles and set pieces. Combined with mods, these games have always provided a way to create little novelty ideas and stories, turning them into something unpolished but tangible. Oh sure, with enough time I could probably make them good enough to be publicly available. I already spend time fine tuning them or at least the parts that interest me. Well-timed music cues. The perfect time of day to compliment a vista. A jet rushing overhead at a pivotal moment. Even the basic waypoint interface and triggers allow for a fairly detailed customisation of events, so no coding is required by any means.

Toys, not tools

There's an argument to be made for its utility as a tool for teaching some game design. I can certainly see a pipeline here for aspiring designers to practice and learn. There's a wealth of tools here and scripting is there for those who want to build far more complex missions beyond what the easy to use options allow. Have a gander through the player made missions being shared and you'll find some really compelling stuff, bending *Arma 3* to accommodate more interesting scenarios than it was ever designed for. For me though, it's simply playing. I'm not really making anything that's for anyone but me.

> "It's typically bogged down in a dedication to military strategy more likely to please hobbyist dads with miniature tank collections."

Arma 3 took this to a whole other level. The mission editor in previous games was limited to an abstracted map screen, which made the fine tuning a bit trial and error as you dove into the mission repeatedly just to see if two objects lined up like they were supposed to. With *Arma 3*, they introduced a full on 3D view so you can place everything perfectly and see exactly how it'll look in-game, speeding up the process immensely. It's also a nicer looking game, and its Greece inspired setting is unique among military shooty games. Though with mods and DLC, you can go anywhere from jungles to the vast Sahara desert. The Zeus mode, a multiplayer tool which lets one player take on the role of GM for some pals, is a great addition even if I've seldom used it myself.

As you would expect its supported by a hefty helping of

MAP SHAKERS

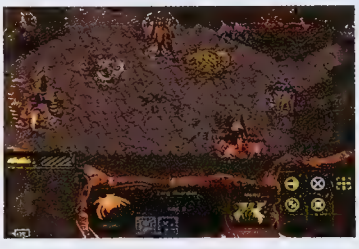
My personal favourite map editors

FAR CRY 4

The thing 4's editor had that made it special was the grappling hook, I brought my preposterous sky pirate missions to life, leaping between airships.

TIMESPLITTERS: FUTURE PERFECT

Not strictly a PC release, but an essential entry in my map editor history. Its simplicity limited its scope but it was still incredibly malleable and permitted enemy patrols and behaviours.



STARCRAFT

The one that started it all. I loved using its RTS sandbox to create what was basically wonky isometric RPG missions. Who needs *Starcraft Ghost* when you can make your own adventure?

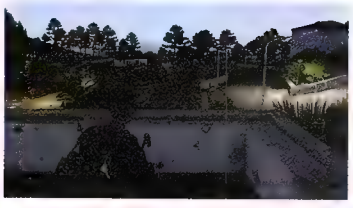
HALO 3

Now on PC, we can all appreciate why this was the mainstay for years among my friends. We broke it with its Forge Mode, making maps with game modes that warped Halo into daftness.

mods, made all the easier with steam workshop integration. The sheer ease of managing and installing mods now would blow teen me's mind, as she fiddles with zip files and ini files. What mods too. There's a wealth of historical setting, including a surprisingly robust pirate mod depicting Nassau. Naturally you have a *Warhammer 40K* mod titled *There Is Only War*. Heck, this is where Brendan 'PlayerUnknown' Greene first created their spin on battle royale. I'm really partial to new maps, like Vinjesvingen, which adds a fictional Norwegian landscape full of gorgeous valleys and lakes.

Halo there

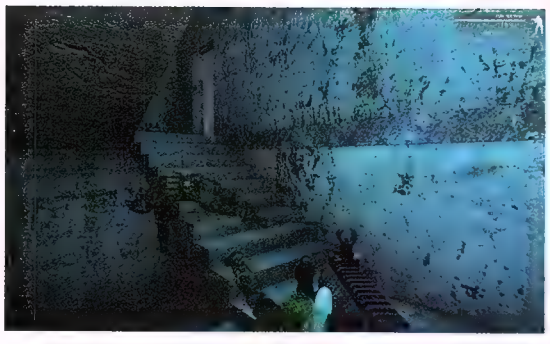
Perhaps the most notable mod is the full blown *Halo* conversion called Operation Trebuchet, for those who want to cast themselves as ODSTs dropping from space or drive around a pelican dropship full of troops. It's extremely impressive, the sheer scale of it alone marking out as a standout mod for any game. The creators are even doing an expansion to bring in the alien Covenant into the game, a game decidedly not built for aliens who shout "Wort! Wort!"

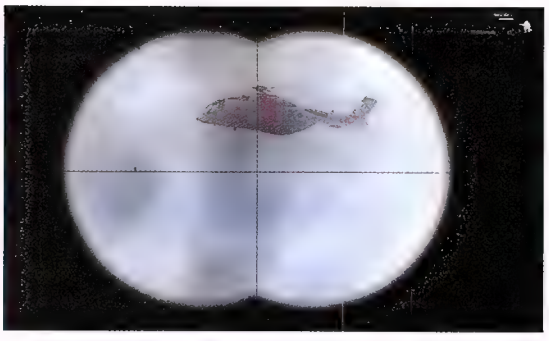


Above: Nothing like a dramatic escape to cap off a mission.

Right: *Arma*'s realism makes even the smallest firefight tense as all hell.

Far right: Deep breath, say it with me, "Get to the choppa!"





So with all this in the mix, what has been my latest effort? I put together a campaign several missions long, playing as a smuggler sent into a warzone to extract some aid worker with rich parents. Cue lots of sneaking around, getting caught up between clashing armies, and a dramatic run for the last plane in town. All culminating in a showdown in a leaky abandoned hotel, outnumbered and outgunned by some special forces lads lurking around every dark corner, hunting you down. A pretty spooky little finale if I do say so myself. I had a lot of fun conceiving of their little road trip, a little bit *The Last of Us*, a little bit *Man on Fire*.

Chaos theory

Despite the varied scenarios I put in, the battles are the centrepiece of the whole thing, and showcase a lot of why I enjoy creating in *Arma* 3 so much. It's rare to have a game put you in as little more than a cog in the machine, to really provide a sense that there's a whole world turning without you. My biggest mission involves a flight across a city to reach a hospital roof and the helicopter waiting there, for a (doomed) escape. Two armies are fighting, block by block, as you weave through alleyways and crawl under wreckage for cover. Fighting isn't really an option, you're just trying to keep yourself and your ward alive. The game manages all this AI, dozens of individuals and helicopters and vehicles, all battling for control. This isn't a tightly scripted set piece like in *Call of Duty*, this is chaos. No two playthroughs will be the exact same. Little moments that emerge wind up being unique little stories.

Dragging myself under a tiny wall while soldiers pelt it with bullets, slowly advancing until an enemy APC rolls in to draw their attention and gives me a chance to flee. Crawling into a tower to retrieve a sniper rifle so I can take down a distant mortar keeping us pinned down.

I put the pieces in place, based on what I think would be interesting, but it's the game which runs a little simulation and produces the moments that make it all worthwhile. That's why it is so viable to just make little missions for myself.

Here be dragons

It's a shame then that mission editors are becoming scarce in games. I can't even begin to imagine the reality of getting any big game out the door these days, let alone while trying to include features so few people will touch. There seemed to be so many more, not so long ago. *Far Cry* included one up until recently. *Halo*'s Forge Mode hasn't quite made it to its latest instalment yet, but it has been the source of many, many fun evenings of friends trying out daft maps and modes together. *WarCraft* and *Starcraft*'s map editors have been used to create things outside the realm of the base game's RTS genre.

The value of map editors isn't about teaching people to create content. To me, the best are about allowing folk to make their own fun. In a gaming landscape saturated with battle passes and matchmaking, all prescribing the way to play, I enjoy blowing the dust off my imagination and making things simply for my enjoyment. *Arma* 3, a military simulator of all things, is freeing like no other game out there. ■

RETRO

Amiga bounces back to life

The Commodore Amiga was one of the most innovative computers ever created, but its legacy has been buried in legalities. David Crookes looks at how it's bouncing back, with a small-size reimagining.

Commodore is a name that resonates strongly with computer users of a certain age. The company that made it famous created the Commodore 64 – still the biggest-selling single computer of all time. It also produced the PET, the VIC-20 and, of course, the Amiga range that was first introduced in 1985 and went on to achieve sales of around five million.

Given such a pedigree, you'd think a revival of the Amiga would proudly bear the Commodore branding. But when such a project was announced by Retro Games Ltd, the name was nowhere to be seen. It didn't appear in the press release; it didn't figure on the images of the packaging; and it won't take pride of place on the new machine itself.

"The Amiga has really been held back over the years by legal issues," explained Jonah Naylor, editor of *Amiga Addict* magazine. And indeed it has. Commodore folded in 1994 and its assets ended up in the hands of Escom, the German PC manufacturer that went bankrupt three years later. But understanding who owns what has been akin to wading in muddy waters ever since. "Thankfully, these legal problems are finally starting to settle," Naylor said with a sigh.

To delve too deep into exactly what has happened over the years would drown us in legalities, take up far too much space and, quite frankly, be prone to error. Suffice to say, the assets, patents and trademarks of the computers and key software are owned by different entities, much to the frustration of a hardcore group of Amiga fans who have remained loyal to the computer for more than 25 years.

"Legal battles have continued to plague the Amiga's future and block continued innovation," lamented Jamie Krueger, one of many enthusiasts determined to keep the computer alive. It's precisely why the new Amiga is called THEA500 Mini (it can't even use the Amiga name), but it seems at least to be on safe ground. "We own our own trademarks and shapes," said Retro Games managing director Paul Andrews. "So basically other third-party legal battles are none of our business."

Above: The Amiga ball is bouncing back into our lives, even if the brand itself isn't.

Below: This prototype shows just how small the new THEA500 Mini actually is.

As the name suggests, THEA500 Mini is doing two key things: replicating the look and feel of the Amiga 500 – the popular model released in 1987 – yet doing so in a case that's far smaller than the original footprint of 325 x 470 x 65mm. You only need to take a cursory glance at the console's prototype to see that it will be barely bigger than the accompanying original-style two-button mouse. But that does mean a compromise has had to be made.

Recalling the past

The clue is in the word "console". Just like a previous product by Retro Games (THEC64 Mini, which was based on the Commodore 64), the revived Amiga won't include a working keyboard. If users want to type, they'll have to use the mouse or the bundled eight-button gamepad to control an onscreen keyboard instead. Users can connect a standard external PC keyboard to the machine, but there's no denying it's already a bugbear for some

Amiga fans, who had hoped that Retro Games would go straight in with a full-size replica of the Amiga 500, just as it eventually did for its Commodore 64 spin-off when it launched THEC64.

"People ask us all the time why we make miniature consoles first," Andrews told APC. "Well, in very rough figures, around 80 percent of the global sales of THEC64 range were the mini version, so the perception that the public want a full-sized working machine with a keyboard is not what we're seeing. We do want to supply that 20 percent with a full-sized working machine as well, though."

But why bother bringing the Amiga back in the first place, small, large or somewhere in between? This is, after all, a machine that hasn't been around for some 25 years, so just what is it about the Amiga that keeps enthusiasts hanging on?

Krueger is clear: "One thing you need to understand is just how personally influential these machines were to countless individuals and how they changed their lives forever. Over the years, I have heard dozens of stories from people that trace their professional careers, lifetime friendships and even how they met their future spouse back to the Amiga," he said.

It also helps that, back in the day, the Commodore Amiga was leaps and bounds ahead of anything available at the time. "It was truly a powerful, elegant and user-centric machine, and it certainly wasn't yet-another-PC, soon to be tossed aside in favour of the newest rehash of the same old thing," Krueger added.

As proof, he points to how the Amiga's Motorola 680x0 CPU in combination with specialised custom chips made it a powerhouse of computing. "The custom chips offloaded many normally CPU-intensive tasks such as graphics, sound processing and other logic, freeing the CPU to execute programs," he explained.

"Its multitasking operating system was also arguably the first truly pre-emptive multitasking OS ever released for a personal computer. When Windows was a mere shell over the mono-tasking MS-DOS and the average PC was barely able to display eight or 16 colours and beep sounds, the Amiga was displaying 4,096 colours, rocking four-channel stereo music and running several programs at the same time."

Don't be fooled by the keys: you'll need to plug in your own keyboard due to size limitations.

Updating a classic

THEA500 isn't going to reinvent the wheel. Instead, it aims to give people a flavour of why the Amiga was so popular. It emulates the original and enhanced chipsets of the Amiga 500 while supporting the Advanced Graphics Architecture of the 32-bit Amiga 1200. Many months have been spent trying to produce an instantly recognisable machine that replicates most of the original's functionality.

To do that, Retro Games struck a deal with Cloanto, which holds the rights to the original Amiga ROMs (though the internal code was created by Retro Games). It also worked hard on perfecting the look of the machine. "A lot of time was spent trying to get the CADs and the mouse just right," Andrews said. "Obviously, much of THEA500 Mini has been made smaller than the original machines, and we've had to make the mouse optical rather than a roller ball. But we've tried to make the machine look and feel right physically, just as we did with THEC64 Mini."

Importantly, the company needed to ensure the new device would work well with today's technology, so there are three USB ports into which you can connect the mouse, gamepad and a flash drive (there's no working 3.5in disk drive, after all). There's also an HDMI port so that the machine can connect to modern TVs. It does mean THEA500 won't be compatible with many past adds-ons. "It's unlikely old hardware will work without extensive mods," Andrews said. But who knows? New third-party hardware may end up being created over time.

For now, built-in software will allow you to replicate the past by selecting multiple scaling options and a CRT filter – the latter allowing the screen to resemble an old cathode-ray tube monitor. There's also a choice between 50Hz and 60Hz screen refresh, and a lot of time has been spent on perfecting the innards; no easy task, given the original machine had dedicated chips to handle different functions as well as direct memory access.

"We've ended up with a compromise between hardware and software complexity," said Chris Smith, Retro Games' chief technology officer, who says the biggest challenge was creating a hardware platform that would provide the power needed to run games at their full frame rate

> "THEA500 isn't going to reinvent the wheel. Instead, it aims to give people a flavour of why the Amiga was so popular."

without tearing at 720p while keeping costs as low as possible. The THEA500 Mini could potentially even run Workbench, the graphical file manager of AmigaOS, as well as serious software such as DPaint, which was used to create many past videogames for the computer. "If it works on emulation, then things could and should work," said Andrews. In reality, we'll have to wait and see.

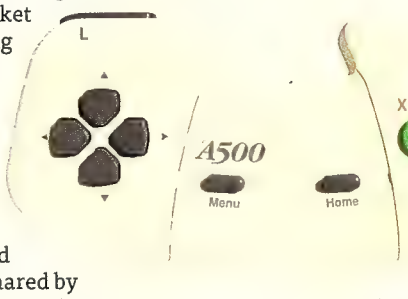
We certainly know that many games will run: THEA500 comes with 25 built-in titles, including *Alien Breed 3D, Another World, Kick Off 2, Pinball Dreams, Simon the Sorcerer, Speedball 2: Brutal Deluxe, The Chaos Engine, Worms: The Director's Cut* and *Zool: Ninja of the Nth Dimension*.

"You will also be able to side-load third party software into THEA500 Mini if you have the legal right to do so and, from day one, we have made the Mini work with WHDload [a software package that makes it easy to install and run floppy-disk-based games]", said Andrews. This also opens THEA500 Mini to the dozens of homebrew games that are being released. "It would be great if THEA500 Mini inspired more people to code again," Andrews added.

In that sense, THEA500 Mini supports the endeavours of the hardcore Amiga fans who have long sought to attract more users to the platform. "This was the machine that launched careers and invented new industries nearly overnight," said Krueger. "It was the machine that NewTek used to revolutionise the television industry with their incredible Video Toaster; the machine that NASA engineers chose to build rocket telemetry tracking hardware around."

To that end, Krueger reckons THEA500 Mini is a "very nice addition to the Amiga world", and it's a sentiment shared by Naylor. "THEA500 will be a showcase for the Amiga as a fantastic gaming machine and it's a nod to a classic computer that many of us started out on," he told APC. "It will also be nice to have an Amiga product available at major retailers again for the first time in years. There are already new and more advanced Amigas available, but these can be expensive and complex to get into."

Above: The ports on the back are compatible with modern technology. **Below:** The controller is modelled on the gamepad originally made for the ill-fated Amiga CD32 console.



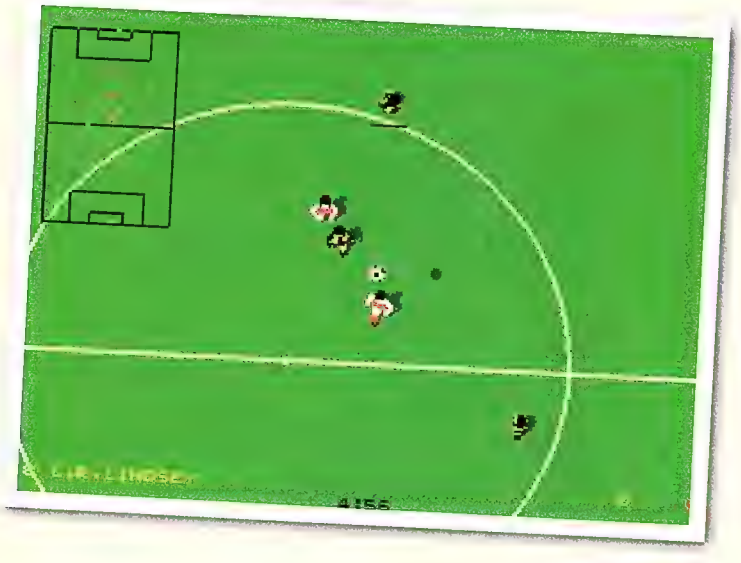
Risky endeavours

Those more advanced machines have been created by enthusiasts. "The community has kept the Amiga alive and thriving," Naylor said. "You only have to look at vital software and hardware releases such as the game hard drive installer WHDLoad, Gotek and OpenFlops floppy emulators, the Compact Flash IDE interfaces and all the many and sundry accelerators to know the Amiga community can achieve anything it wants to, if it puts its mind to it. There's a surprise around the corner every week."

One of the biggest developments over the years has been the creation of a "Next Generation" line-up of Amiga machines. These have far surpassed the capabilities of the original Commodore line-up – the one that THEA500 Mini emulates and which the Amiga community calls Classic.

Next Generation describes the higher-powered PowerPC-based machines that have since been made by enthusiasts, including the AmigaOne X5000 developed by A-EON Technology. "The custom chips are gone and replaced with the same PCI-E expansion bus, RAM, storage controllers, USB interfaces, video and audio hardware as can be found in the PC," Krueger said. "The main CPU is the RISC-based PowerPC instead of the more common CISC-based X86 architecture, but performance is comparable."

Krueger says the Next



You can play games such as *Zool* and *Kick Off 2* straight out of the box, but you can also import your own software.

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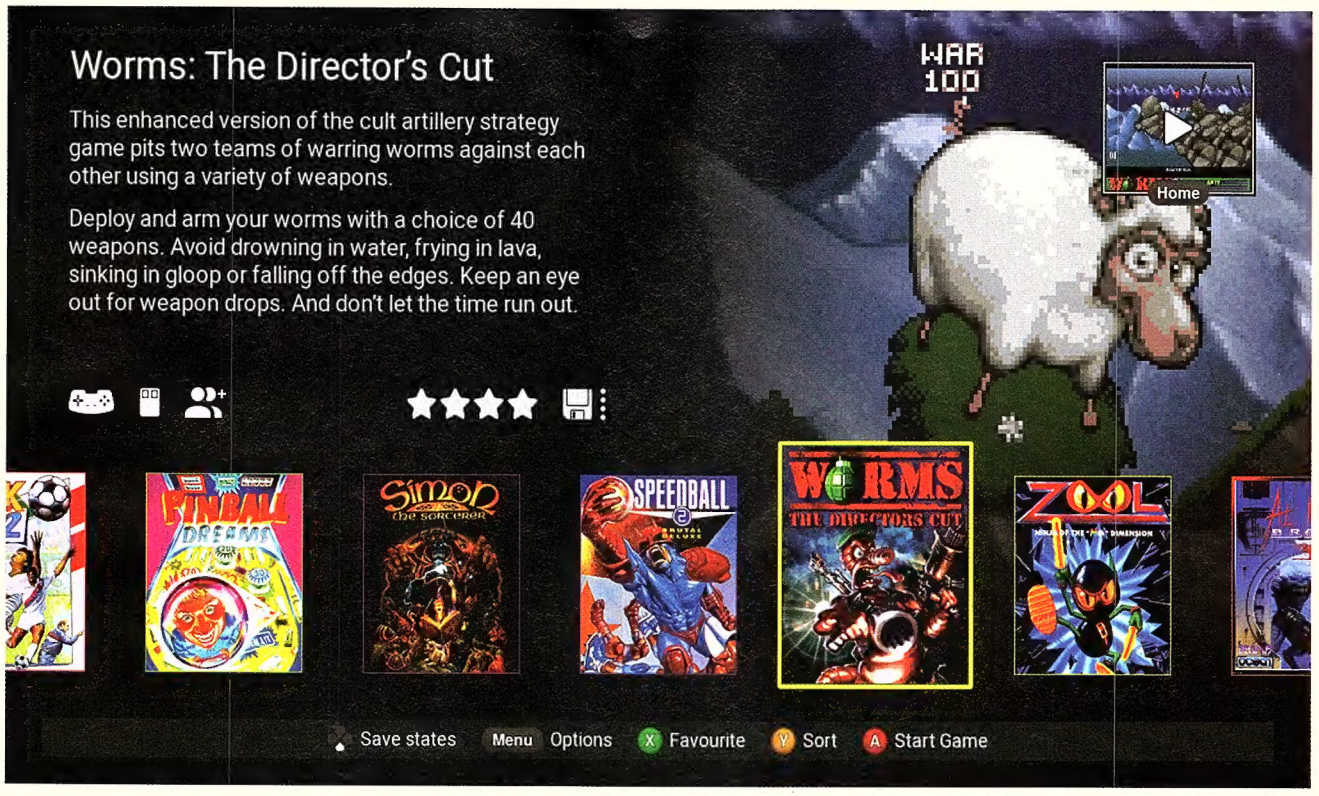
Worms: The Director's Cut
This enhanced version of the cult artillery strategy game pits two teams of warring worms against each other using a variety of weapons.
Deploy and arm your worms with a choice of 40 weapons. Avoid drowning in water, frying in lava, sinking in gloop or falling off the edges. Keep an eye out for weapon drops. And don't let the time run out.
WAR
100
Home
Pinball Dreams
Simon the Sorcerer
Speedball 2
Worms The Director's Cut
Zool
Save states
Menu Options
X Favourite
Y Sort
A Start Game

Generation Amiga machines share the original Amiga operating system at their core. "The Next Generation machines run PowerPC-based AmigaOS 4.x, while the Classic machines run 68K-based AmigaOS 3.x," he said. What's more, both AmigaOS4 and AmigaOS3 are still in development.

Krueger spends time porting the AmigaOS to modern hardware while continuing to develop it for the Classic line. "The primary accomplishment of the AmigaOne X5000 has been to provide a truly fast way to run AmigaOS with modern resolutions on a dedicated system rather than emulation." In that sense, it's a world apart from THEA500 Mini, so will he still buy one of Retro Games' machines?

"In general, I am in favour of anything that brings new awareness to the Amiga computers," he said, before sharing that he already has his own plans for it, albeit perhaps not quite what Andrews and his team had intended. "Personally, I will take THEA500 Mini apart, build it into a full-size A500 case and make use of a full original A500 keyboard adapted to USB. I want to see how far I can push the emulation system."

But then this will be the ongoing attraction to many Amiga users: to see just what mods and hacks they can perform on THEA500 Mini. By pushing at the boundaries of the technology they have at their disposal, they'll merely be continuing the trend that started all those years ago when Commodore was a force to be reckoned with.

"The Amiga was years ahead of any other home computer when it was released in 1985," said Naylor. "In fact, the original was so groundbreaking that it hardly changed in the next ten years – it took that long for the competition to catch up. The community loves the Amiga because it is more than just a great games machine, and could wipe the floor with the PC and Mac in its day. But more than that, the Amiga doesn't just feel like a tool to achieve your goals. Its whole ethos is one of innovation and community."

So to the big question: how much and where to buy? You can order THEA500 Mini from Amazon for $199, and the official sirte is at **retrogames.biz/products/thea500-mini/** and it's packed with info and a very good FAQ. ■

Above: The 25 built-in games can be easily selected from a carousel.

You can order THEA500 Mini now.

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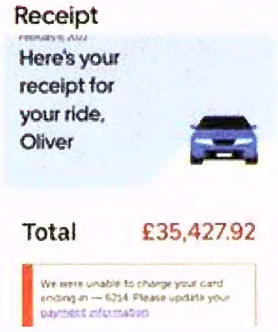
CHIP CHAT

JOEL BURGESS REPORTS ON THE UNUSUAL SIDE OF TECH NEWS


Receipt
Here's your receipt for your ride, Oliver
Total
£35,427.92
We were unable to charge your card ending in — 6234. Please update your payment information

UBER CHARGES PASSENGER £35,000 FOR 6.5KM TRIP ACCIDENTALLY SET TO AUSTRALIA

'Just to the other side of the world please'.

22 year old Oliver Kaplan ordered an Uber from a city near Manchester, England to a destination no more than 15 minutes away, after work in October. He was quoted £10-11 for the trip by Uber at the time, but received an email the next day saying that he had insufficient funds to process his £35,427.92 (around AUD$62K fare. Uber acknowledged that its system had mistakenly entered the destination as somewhere in Australia which caused the 'extremely high' automated fare and reversed the charge. Considering the previous story, and how much Uber charges for the 15,000km journey from England to Australia, maybe it really could run profitable return shuttles from the 408km high ISS... at least if it timed it right.

EU PARLIAMENT FELLOWSHIP DECIDES USB-C IS THE ONLY ACCEPTABLE PHONE CHARGER.

One charger to rule them all.

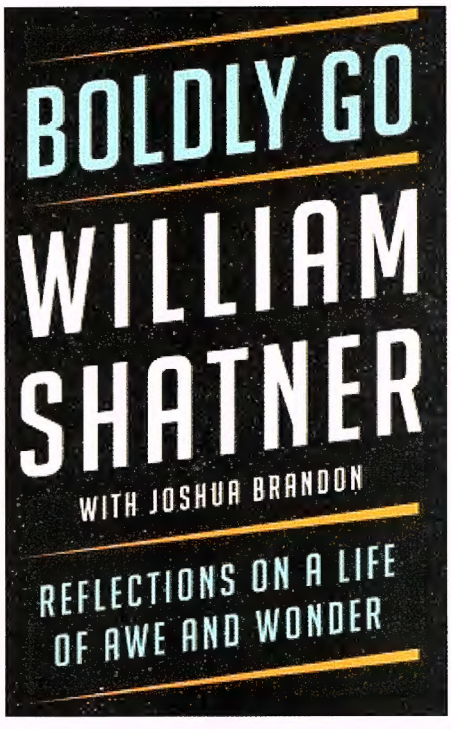
There are many instances of Apple developing its own proprietary tech to offer a different solution to the competition, but it seems none have frustrated the European Union parliament quite as much as the Lightning Cable. Following an almost unanimous vote it was decided that having two types of phone charging cables was far too many for any household, and that any phones sold in the EU must, henceforth, be charged with a USB Type-C cable only. The governmental body isn't planning on pulling iPhone 14 devices off the shelves, since the ruling doesn't take effect till the end of 2024.

CHIP CHAT

Woman sent US$30k to online lover for return fare from the ISS

Ain't no space station high enough to keep me from gettin' to you, baby.

A Japanese newspaper reported that a 65 year old woman from a province just outside of Kyoto was defrauded by 4.4 million yen (close to AUD$50K) by a man claiming to be a Russian Cosmonaut needing to pay for his return trip to Earth. Local Police didn't release the exact Instagram correspondence, but we assume that it must've claimed that Russia's war on the Ukraine means the country is so poor it can't afford to land its astronauts back on Earth. Considering a seat on Virgin Galactic's suborbital space flight costs US$450,000, $50K doesn't even seem like it's enough for an UberPool fare from the ISS, but we guess the bond of this internet love was strong enough to convince the lady otherwise.



SHATNER DESCRIBES HIS SPACE EXPERIENCE AS ONE OF 'OVERWHELMING SADNESS'

"All I saw was death."

In October 2021, William Shatner, was one of a handful of people chosen to accompany Jeff Bezos on Blue Origin's premiere New Shepard commercial spaceflight. At the time, Shatner described it as "the most profound experience I can imagine", but in a recently released memoir titled 'Boldly Go', Shatner details exactly what he meant by that. "My trip to space was supposed to be a celebration; instead, it felt like a funeral", he writes. The *Star Trek* Captain, reminisces that the experience made him feel like mankind wasn't doing its best to look after the planet, a sentiment that is shared with numerous articles on the expedition including: Global Citizen's 'Seven things that Jeff Bezos's could've fixed with the $5.5Bn he spent on a four minute spaceflight'.

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